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ABSTRACT

GRADES OR AGES: Grades K-6. SUBJECT MATTER: Science; plants. ORGANIZATION AND PHYSICAL APPEARANCE: This guide is divided into the following sections: initiatory activities, developmental activities with 36 concepts, evaluation, vocabulary, children's books, and films. The guide is mimeographed and spiral-bound with a soft cover. OBJECTIVES AND ACTIVITIES: Activities are listed for each of the concepts. The objectives involve an understanding of the concepts and a correct interpretation of the results of the experiments. INSTRUCTIONAL MATERIALS: The material needed for each activity is listed. The bibliography and film list are both annotated. STUDENT ASSESSMENT: Samples of evaluation items are included to help the teacher develop an informal testing program. (MBM)

RESOURCE HANDBOOK - PLANTS

(A supplement to Basic Curriculum Guide - Science)

Grades K - 6

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SCHOOL CITY OF GARY

Gary, Indiana

1968

PREFACE

The teaching of science in the elementary school is a responsibility of major significance. Through our efforts pupils should be helped to gain an understanding of science in the development of our culture. Likewise, we should emphasize the development of the ability to write and recognize social uses of science in daily life. In developing the ability to understand their natural environment, the pupils must also have a complete understanding of the process involved.

There is a need to improve teaching and learning in science continuously. New materials of instruction, new teaching approaches, and the continuing responsibility to meet the individual needs of students place great demands on all professional staff members to appraise the quality of teaching and learning in science. This publication represents an effort on the part of staff members within our school system to assist all staff members in improving the teaching and learning in science. It is hoped that all staff members who use this publication will find it to be of value.

Norman R. Turchan

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Director of Instruction

ACKNOWLEDGMENTS

I wish to express appreciation to the members of the Elementary Science Materials Committee for their extra effort in the preparation of this publication. The publication is a composite of materials which have been developed previously, combined with new material. Much of the material presented in this publication is the result of their intensive work and effort.

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

PLANTS

Initiatory Activities

Have the children:

1. Place potted plants, books about plants, and plant pictures in attractive displays around the room. Try to create an environment which focuses the attention of the children on plants and which will cause them to ask questions that help initiate a unit.

2. Take an excursion in the school neighborhood to observe the variations in sizes and kinds of plants.

3. Prepare a bulletin board display of pictures showing plants growing in and near a pond; on a prairie; on a mountain; on a desert; in a jungle forest and in other environments.

4. Take an excursion to observe and discuss the differences in plants that grow in direct sunlight and those that grow in shady areas.

5. Take a flowering plant out of the pot and shake the dirt from its roots. Examine the roots, stem, leaves, and flower. Discuss the functions of each part.

6. Make a collection of plant pictures. Group these according to some feature such as size, type of reproduction structures, kinds of leaves, or place they grow; use them as a bulletin board display.

7. Discuss the importance of plants in providing man with food, shelter, fuel, clothing, and beautiful recreational areas.

8. Discuss the dependence of all animals, including man, on plants.

9. Make a list of all the products used by them in one day that are provided by plants.

10. Discuss some of the plants we use for food. Identify the parts of plants eaten.

11. Make a collection of pictures of plants that have adaptations that help protect them from being eaten by animals.

12. Display pictures of poison ivy, oak, or sumac. Discuss the distinguishing characteristics of these plants.

13. Make a list of plant stems important as a source of food for man.

14. Discuss some of the characteristics of certain plants that most animals will not eat. Some examples are skunk cabbage, thistles, milkweeds, and cockleburs.

15. Make a collection of leaves. Notice the different vein patterns; group the leaves according to similarities in vein patterns.

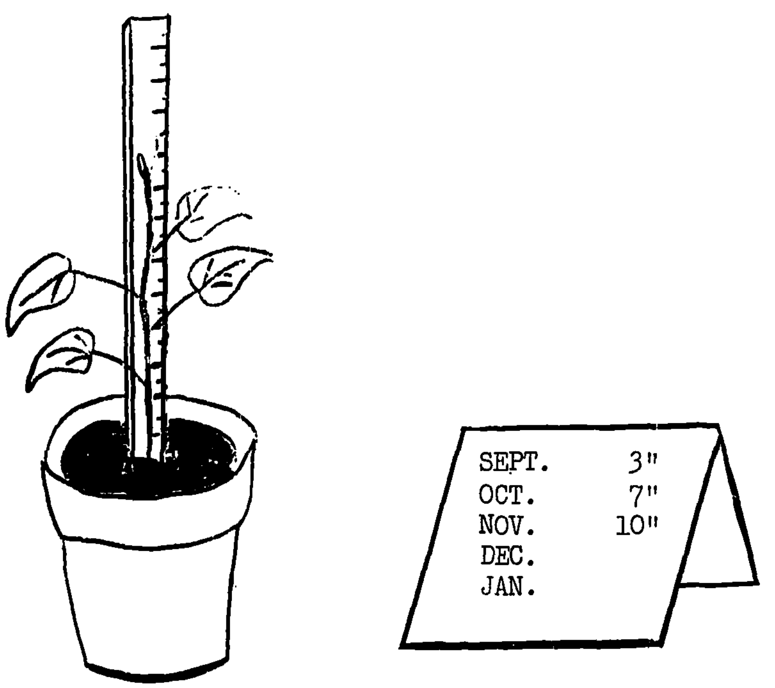
Developmental Activities

CONCEPT - Plants grow.

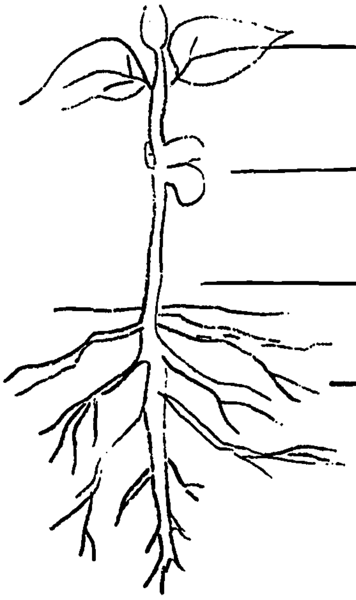
1. Observe the growth of small young plants. Place a ruler in the soil next to the plant at regular intervals, indicate with red crayon the height of the plant. (Geraniums and begonias are suitable for this purpose.)

2. Plant lima bean seeds in six or seven small containers and observe the growth of the young plants.

3. Observe lawns about the community. Discuss the growth of the grass, and the mowing of the grass.



OBSERVE THE GROWTH OF A SMALL PLANT



YOUNG BEAN PLANT

PARTS OF A PLANT

Root	Keeps plant in ground Takes in water Stores food
Stem	Holds leaves up Carries water to leaves Carries food from leaves to other parts of plants
Leaf	Food for plant is made here
Flower	Produces seeds
Seed	Produces new plant

4. Use six of the bean plants previously sprouted. Place two in a dark closet or cabinet, two in the refrigerator or other cold place, and two in light. Water one of each pair as needed. Observe and compare the plants at intervals.

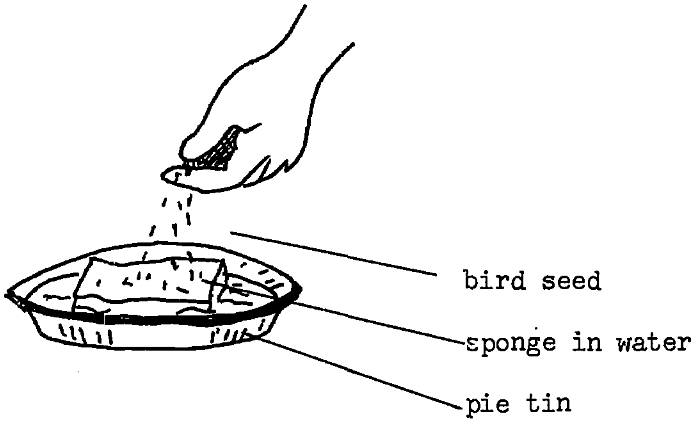
5. Develop an experience chart to record the demonstration described above. The abilities of the children will determine the complexity; pictures can be used in place of some of the words. The chart should include:

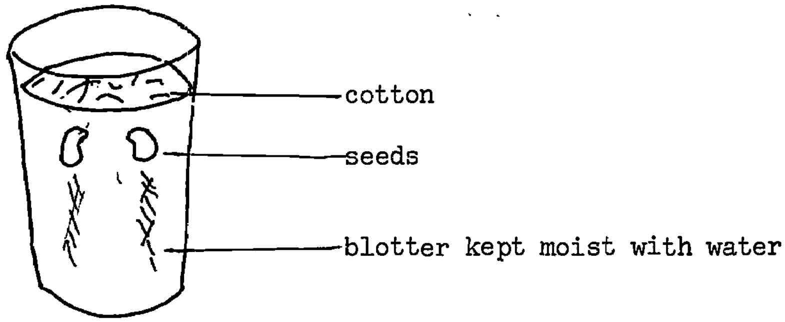
   What we wanted to find out
   What we used
   What we did
   What happened
   What we learned

6. Show a symmetrical geranium to the children. Place it on the window sill in the same position for about a week. Notice the leaves. (They will all be turned to the light.) Turn the plant so that the leaves face the classroom. Repeat the demonstration.

7. Sprout a variety of seeds: grass, bird, radish, bean, corn, apple, orange, grapefruit. Notice the different ways in which they come out of the soil.

8. Conduct research concerning edible seeds.





RECORDING EXPERIMENTS

Look and See

See the in the

See it grow.

See the in the

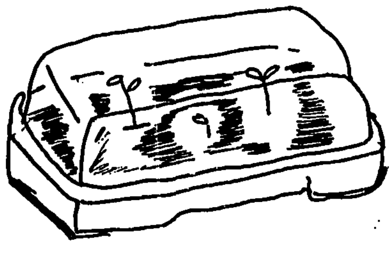
See it

Do This

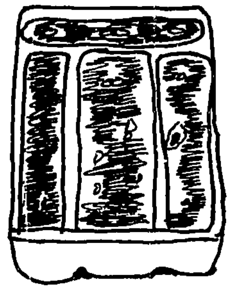
Put 2 in the

1 of the

See this get



Butter dish garden



Cutlery dish serves as a planter for a variety of seeds.

CONCEPT - Each part of a seed helps in the growing of a new plant.

1. Soak enough lima bean seeds overnight so that each child will be able to have one. Give each child a seed that has been soaked and one that has not been soaked. With a toothpick have each child try to remove the seed coat from the seed that has not been soaked. Then try to remove the seed coat from the seed that has been soaked and observe how much easier the coat is removed. This shows that each seed when planted in the ground has to be well soaked in order that the inside of the seed can break through the seed covering or "shell." Notice that the bean is divided into two "fat halves." The baby plant should be seen emerging from the place where the two fat parts are joined. The three parts of the seed are now observed:

    the seed covering, which protects the new plant

    the two "fat halves" which contain food material for the new plant

    the tiny new plant

2. Plant some lima bean seeds. Note that the plant "lifts" itself out of the seed covering after the root has started to anchor the plant; the seed covering remains in the soil. Note that the "fat halves" remain on the bottom part of the plant stem and that these "fat halves" get progressively smaller as the food in them is used up by the plant.

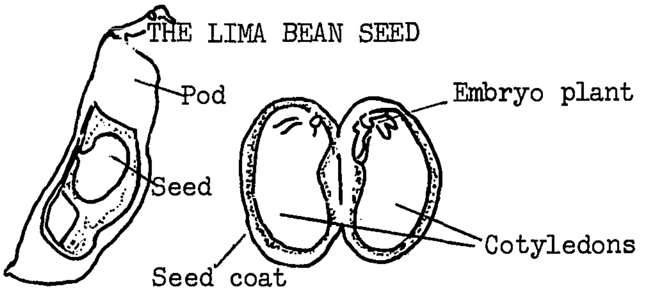
3. Problem

What is the structure of seeds?

Materials

Lima bean seeds (packaged garden seed, not cooking beans) paring knives.

Procedure



The night before you plan to use this Activity, soak half of the lima bean seeds in water so that the seed covering will be soft. Distribute several of the dried lima bean seeds to the children and ask them to describe the seeds. They should notice that the seeds are smooth, hard, and dry, and they should be able to find the place where each seed was attached to the plant. Then distribute the seeds that have been soaked overnight and ask the children to break the coatings of the seeds and open them. Ask the children to describe the parts of a seed. Have the children describe the coat of the seed and suggest its function. (The seed coat protects the content of the seed.) Ask the children to describe the contents of the seed and to suggest the function of the parts. They should notice that there is a tiny plant between two cotyledons. The tiny plant develops into the adult plant, and the cotyledons contain stored food.

Results/Conclusions

A seed consists of a protective coat, an embryo plant, and one or more cotyledons that contain food for the growth of the embryo plant.

CONCEPT - Seeds will germinate in any substance that is kept properly moist.

1. Problem

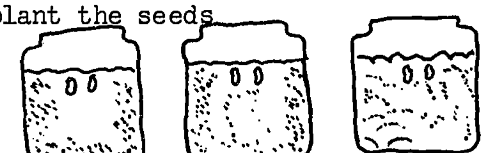
Is soil necessary for the germination of seeds?

Materials

Lima bean seeds (packaged garden seed), potting soil, sawdust, cotton, glass jars, water, rulers.

Procedure

Have the children pack soil in one jar, sawdust in the second jar, and cotton in the third. Make sure that the materials are not packed too tightly (The seeds require air for germination.) Next have the children plant the seeds



about $\frac{1}{2}$ inch beneath the surface of the material in each jar. The seeds should be placed near the outside of the glass where the children can watch them to see if they germinate. After the seeds are planted, each jar should be watered, making sure that just enough water is added to moisten the material in which the seeds are planted. The jars should be placed in a warm part of the room. Each day the children should check them for moisture, adding water as necessary to keep the material moist. For ten days the children should watch the seeds for evidence of germination. In a chart like the following, they should record their observation of how soon the seeds germinate, how high the young seedlings are, what structures appear, etc.

COTTON

Time	Time of Germination	Height of Seedling	Other
1 day			
2 days			
3 days			
4 days			

After the children have made their final observations, encourage them to answer the following questions. Did the seeds that were planted in sawdust germinate? (Yes.) Did the seeds that were planted in cotton germinate? (Yes.) Did the seeds planted in soil germinate? (Yes.) Was there any noticeable difference in the ability of the seeds to germinate sucessfully? Or will seeds germinate in any moist material? (As the children learned in the previous activity, seeds contain their own food supply. This makes it possible for them to germinate in any moist material because they do not need additional food.)

As far as the children now know, what is the one requirement for the successful germination of seeds? (The proper amount of moisture.)

Results/Conclusions

Soil is not necessary for seeds to germinate. Seeds will germinate in material that is kept properly moist and that permits air to reach them.

CONCEPT - Seeds can germinate at any depth of planting but only seedlings planted at shallow depths will reach the surface and develop into new plants.

1. Problem

What effect has the depth of planting on germination and growth into new plants?

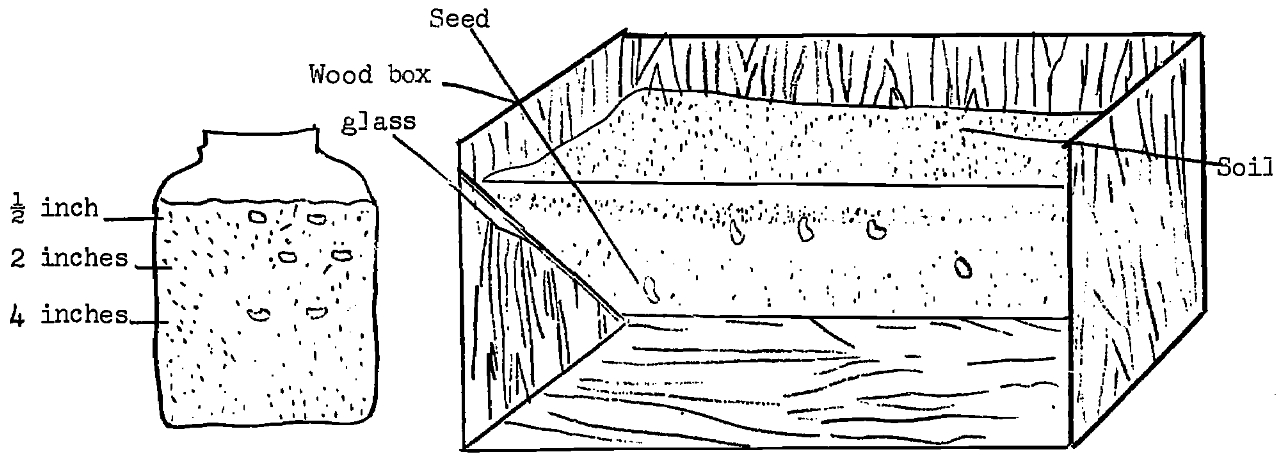
Materials

Several kinds of seeds, such as bean, corn, cucumber, radish, and pea seeds (packaged garden kind), several large glass jars (1 gallon pickle jars, one for each kind of seed), or a glass-sided root box, potting soil, rulers, grease pencils or crayons, water.

Procedure

Divide the children into groups. Give each group one kind of seed and one jar, which they should prepare as follows. Using a grease pencil or crayon, make a line near the top of the jar (this will be the level of the soil when the experiment is completely set up). Then measure down from this and make three more marks, one $\frac{1}{2}$ inch from the top line, one 2 inches from the top line, and one 4 inches from the top line. (These marks will indicate the various depths at which the seeds will be planted.)

Now have the children put soil into the container until it reaches the 4-inch line they have marked off. The soil should be loosely packed, as they have learned to do in previous activities. They should then place several seeds on the soil next to the glass (so that they can watch them for evidence of germination). Next they should add more soil, packing it loosely, until it reaches the 2-inch mark. Again, they should place several seeds next to the glass. (If a jar, rather than a root box, is used, make sure that the seeds are not directly above the seeds on the 4-inch level.) The children should now add more soil bringing the level up to the $\frac{1}{2}$-inch line, and again place several seeds on the soil, taking care of the lower levels. They should then add more soil to cover these seeds and to bring the soil up to the line they have marked for the top level. When this is completed, each group will have a jar in which seeds are buried in $\frac{1}{2}$ inch of soil, 2 inches of soil, and 4 inches of soil. For the rest of the experiment, water should be added as necessary to keep the soil properly moist. The jar should be kept in a warm dark place in the classroom---in a closet, for example.



The children should watch the seeds for four days. Each day they should record how many seeds have germinated in each jar. They could keep their record in the form of a chart. At the end of the four days discuss the results with the children. How many of the seeds germinated at the ½-inch level? At the 2-inch level? At the 4-inch level? (Most of the seeds at each level should germinate.) Does the depth of planting have an effect on the germinating ability of seeds? (No.) Encourage the children to give their ideas about why seeds are planted at shallow depths. (They probably will not know the answer.) Suggest to the children that if they keep the jars they may be able to find out why seeds are planted at shallow depths. Keep the jars in the dark and water them often enough so that the soil will be kept moist. After a week's time the children should record how many seedlings in each jar have appeared above the surface. They should also note from what level the seedlings came up. They may then watch the seeds for another week or two to see if any more seedlings come up. Their observations can be recorded on a chart such as the following:

JAR 2 - CORN

Level at Which Seeds Were Planted	Number of seeds That Germinated	Number of Seedlings That Came Up
½ inch		
2 inches		
4 inches		

When the experiment is completed, ask the children the following questions. How many seedlings came up? Did any of the seeds planted at the 4-inch level come up? (No.) Did any plants from seeds planted at 2-inch level come up? If so, what kind? (The plants from large seeds, such as corn, probably did. Plants from small seeds, such as radish, probably did not.) Did any of the seeds that were planted at the ½-inch level come up? (Probably all the plants from seeds that germinated came up.) Can the children explain why the seeds planted 4 inches deep did not come up? They may not be able to do this. The following questions may help to elicit the answer. Where do germinating plants get their food? In a previous activity the children cut the lima beans in half. Inside they saw a tiny young plant. They were told that the rest of the bean was stored food material for the tiny plant.) Now ask them where mature plants get their food. (They have been told that plants manufacture their own food and that they can do this only in the sunshine.) What would happen to a seed if it ran out of stored food before it got to the surface and could make its own food? (The seedling would die.) Why did some seeds that were planted 2 inches deep come up and others did not? (Larger seeds have more stored food than tiny seeds. Tiny seeds must be planted very close to the surface so that they will not run out of food before they get into the light where they can make their own food.)

Results/Conclusions

The depth at which seeds are planted has no effect on their ability to germinate. They will germinate at any depth as long as they have the proper amount of air and moisture and are kept at a suitable temperature. If seeds are planted too deep, however, the seedlings that develop will die before they reach the surface. This occurs because the seedling runs out of stored food before it gets into the sunlight and can make its own food. Seeds should be planted at shallow depths.

CONCEPT - Seeds need both water and air for germination.

1. Problem

Is water and air needed for germination?

Materials

Lima bean seeds (packaged garden seed, not cooking beans), potting soil, 3 glass jars.

Procedure

Suggest that the children divide the bean seeds into three groups. Fill each of the glass jars above 3/4 full with potting soil. Have the children poke several bean seeds between the inside of the jar and the potting soil so that the seeds are about ½ inch from the surface of the soil. Ask the children to label each glass jar with a number. Explain to them that labels are necessary to keep accurate records. Have the children place all three jars in a warm location. The seeds in Jar 1 will receive no water at all. The seeds in Jar 2 will be watered just enough to keep the soil moist. The seeds in Jar 3 should be watered until water appears above the surface of the soil.

Jar 2 and 3 should be watered to maintain the conditions described. Have the children observe the jars each day and keep records of the seeds' growth.

After a week, discuss the results the children have observed. The seeds in Jar 1 should not have sprouted at all. Why? (The seeds in Jar 1 received air but did not receive moisture. Both air and moisture are required for germination.) The seeds in Jar 2 should have sprouted. Why? (The seeds in Jar 2 have received both air and moisture.) The seeds in Jar 3 should not have sprouted and may even have begun to rot. Why? (Seeds require both air and moisture, but moisture without air is not sufficient for the germination. The seeds in Jar 3 were always completely covered with water and, therefore, received no air.)

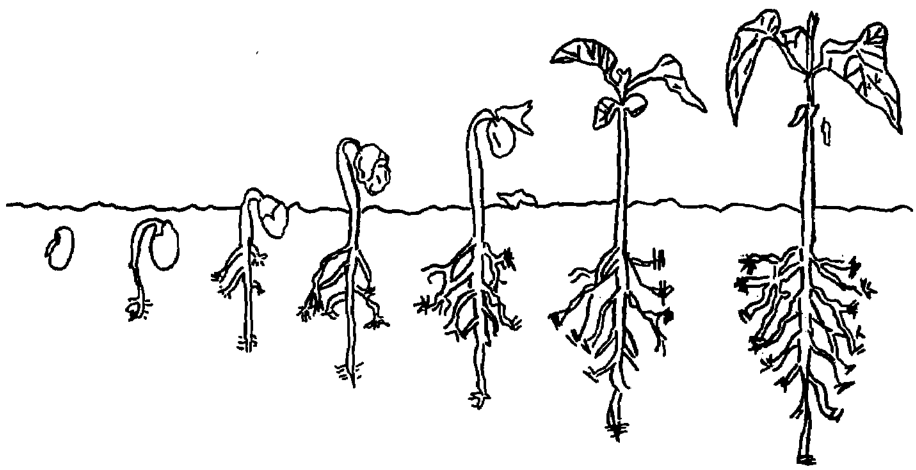
Results/Conslusions

Seeds require the proper amount of both water and air in order to germinate. During the germination period, seeds use food stored in the cotyledons.

NOTE

In the germination of seeds, the embryo plant uses both air and water to grow. The children may wish to continue to observe the development of the plant. They should notice that as the plant grows, the cotyledons become smaller as the stored food is used up. Eventually, they drop off entirely when the plant has produced additional leaves and is able to make its own food. (Notice the following illustration.)

GERMINATION OF A BEAN SEED



2. Problem

Does water help a plant to grow?

Materials

Two containers (be sure to punch holes in the bottom of them), soil (garden or flower pot), two seeds (radish or lima bean).

Procedure

Fill the containers with soil and plant one seed in each container about one inch deep. To each container add water and to the other do not add water.

Result/Conclusion

The container containing the plant that is receiving water will have growth while the other seed will not grow.

CONCEPT - One of the conditions affecting seed germination is temperature. The temperature needed for germination varies, depending on the kind of seed.

1. Problem

What effect has temperature on the germination of seeds?

Materials

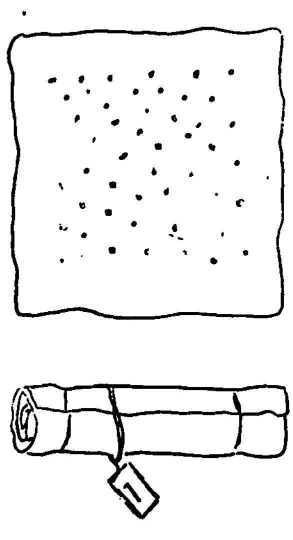
Radish seeds (packaged garden kind), sunflower seeds (packaged garden kind), wheat seeds (packaged kind), 9 pieces of clean cloth cut into 12 x 12 inch squares (Terry cloth toweling works very well), water, rubber bands, freezer, refrigerator, 3 thermometers.

Procedure

Explain to the children that in this activity they will try germinating seeds at three different temperatures. Suggest that they can also find out if different seeds germinate at different times by using three kinds of seeds: radish, wheat, and sunflower.

Have the children moisten the nine pieces of cloth and then wring them out so that no water is dripping from the cloth. Then spread the cloth out on a waterproof surface. Have the children count out three piles of each kind of seed with fifty seeds on a moist cloth, and spread out the seeds so that they will not be in contact with each other.

Roll the cloth and fasten the ends with rubber bands. The rolls should be labeled with different numbers: 1 for radish, 2 for wheat, and 3 for sunflower.



Have the children place one roll of each kind of seed in the freezer in the school kitchen. If there is no thermometer in the freezer, have them place a thermometer in the freezer. (If no freezer is available in the school, one of the children might take the roll home and place it in the home freezer.) Next, have the children place one roll of each kind of seed and a thermometer in the refrigerator. One roll of each kind of seed should be kept in the classroom at room temperature. The rolls in the refrigerator and in the classroom should be kept moist during the experiment.

For ten days, at intervals of two days, have the children unroll the cloths and count the number of seeds that have germinated in each set. They should also make a record of the temperature in each of the places where the rolls are kept. Their observations can be recorded in a table such as the one illustrated. After the children have made their final observation, encourage them to answer the following questions. How many of the seeds in the freezer germinated? (None.) Did any of the seeds in the refrigerator germinate? (Some of the wheat seeds may have germinated. Wheat seeds may start germinating at temperatures only slightly above freezing. None of the other seeds should germinate at temperatures less than 68° F.) How many of the seeds in the classroom germinated? (The majority should have; those that did not may have been too old, damaged, or inactive.) What kind of seed germinated first? (Radish.) Can seeds germinate when they are kept below freezing? (No.) Can seeds germinate in the cold? (Some seeds can germinate in fairly cold conditions. The wheat seeds may have germinated in the refrigerator.) Under what conditions did most of the seeds germinate? (At room temperature.) What is necessary for most seeds to germinate? (Warm surroundings.)

Results/Conclusions

Temperature has an effect on germination. Most seeds germinate best at warm temperatures. Seeds will not germinate at temperatures below freezing. Some seeds, such as wheat, can germinate at relatively cold temperatures. Some seeds require a longer time to germinate than others.

RADISH

Number of Seeds Germinating

Days	Freezer	Refrigerator	Classroom
	Temp.	Temp.	Temp.
2			
4			
6			
8			
10			

2. Demonstration

Fill four pint jars half full of sand and water; place two bean seeds on the sand in each jar. Lay the glass cover on each jar.

Place one jar in a warm, dark place.
Place one jar in a refrigerator or cold place.
Place one jar in a shady place.
Place one jar in a sunny spot.

Keep the sand moist during the demonstration. It should be concluded that seeds need to be warm to sprout and they sprout sooner when kept in a dark place.

3. Problem

Does heat help plants to grow?

Materials

Two identical green deciduous plants, two containers, soil, water, dry ice.

Procedure

Plant one plant in each container. Give each plant an equal amount of water. Leave one container at room temperature, and pack dry ice around the other container. Have the children observe the difference in the plants as the one plant wilts from the cold.

Results/Conclusions

Heat helps plants to grow. The cold causes the plant cells to rupture, thereby destroying them.

CONCEPT - Light is essential for normal plant growth. When placed in the dark, green plants turn yellow because they do not manufacture the green pigment, chlorophyll.

1. Problem

Do green plants need light to grow properly and to remain green?

Materials

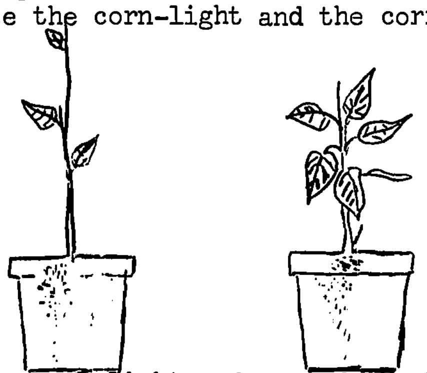
Bean seeds, corn seeds, potatoes with "eyes," flower pots, potting soil, dark closet or cardboard cartons, rulers.

Procedure

Have the children plant duplicate pots of corn seeds, bean seeds, and potato "eyes"; about three seeds or potato "eyes" per pot will insure examples of seed germination. The seeds should be planted about $\frac{1}{2}$ inch deep in the soil and watered so that the soil is moist. Have the children label the pots: bean-light, bean-dark; corn-light, corn-dark; potato-light, potato-dark. The bean-light will be where it will receive light, the bean-dark in the dark, and so forth. The plants that receive light will serve as a control and enable the children to observe what a normal plant looks like.

Place the light plants on a classroom window sill that receives light, and keep them there for the duration of the activity. Place the dark plants in a closet. If a closet is not available, the dark plants can be kept in the room, but they must be covered with a cardboard carton that does not permit light to enter it. (Holding the carton over your head while looking at a light fixture is a good test to determine if any light enters the carton.) Both sets of plants should be watered as needed to keep the soil moist. The temperature of both locations should be about equal.

In about two weeks the plants will have germinated and grown enough for observation. Place the corn-light and the corn-dark plants



next to each other, the bean-light and bean-dark plants next to each other, and the potato-light and potato-dark plants next to each other. Ask the children what they observe. (They should be able to see the following differences between the light and the dark plants: Light---green in color, stem sturdy, leaves developed. Dark---yellowish in color, long spindly stem, tiny leaves, places where the leaves grow widely spaced. If the leaves do not grow at all, these spaces may appear as bumps on the stem. If necessary, have the children measure the spaces between the bumps on the dark plants and compare them with the spaces between the leaves on the light plants.)

Ask the children what they can deduce from this experiment. Do plants grow in the dark? (Yes.) Do plants grown in the dark grow normally? (No.) What do they look like? (Long stems, tiny leaves, yellowish color.) What can the children conclude from the appearance of a plant grown in the dark? (Light is required for plants to grow normally.) Ask the children what makes plants green. (Chlorophyll in the leaf.) If the dark plants are not green, what can the children surmise? (Chlorophyll was not present in the leaf.) The children may conclude that leaves manufacture chlorophyll in the light, but not in the dark.

Results/Conclusions

Plants need light in order to grow properly and to be green. Plants grown in the dark have long spindly stems and tiny underdeveloped leaves and are yellow in color. Plants make chlorophyll, the green pigment, only in the presence of light. Plants do not make chlorophyll in the dark.

2. Demonstration

Transplant four tomato plants that are at least 4 inches high into containers. Cover the first potted plant with a container with a two inch hole at one side and put the plant in sunlight. Put the second potted plant in a dark closet. Put the third potted plant in a sunny window. Place the fourth potted plant in the same spot where it has been. Give each plant the same amount of water each day. After one week observe and develop conclusions from the results. The plant in the first pot is tall, yellow, and growing toward the hole in the container. The second plant is scrawny. The third plant is green and healthy. The fourth plant is green and healthy and growing toward the light. This will indicate that plants need sunshine when they come above the ground.

3. Problem

Does light help plants to grow?

Materials

Two identical plants, soil, water, two containers.

Procedure

Fill the containers with soil and place one plant in each one of them. Give each plant equal amounts of water. Place one plant in light and the other in a room, closet, or cabinet. Wait for a few days.

Results/Conclusions

The plant in the light is growing normally and has good color. The other has no color and looks sick. Plants need light in order to grow normally.

CONCEPT - Plants store food in seeds, roots, stems and leaves.

1. Demonstration

Cut a thin slice across a potato and hold it up to the light. Notice its resemblance to a tree stem with bark and a center like the heart of a tree. Mix some iodine with water to make a light brown liquid. Put the potato slice in a white saucer and cover the slice with the iodine solution. What happens? Hold the slice up to the light. The starch will be found stored in the center of the potato. Compare a white potato and a sweet potato. Sweet potatoes are roots, not stems like the white potato. Test the sweet potato for starch. Test it for sugar by the taste method. A cabbage is a bunch of leaves wrapped around a stem. Test the cabbage for starch and sugar. It will have a little starch in it. Display several vegetables on the exhibit table showing the part where the food is stored.

2. Demonstration

Place on the display board a picture of sweet potatoes and carrots which should be identified as roots; white potatoes and celery which are stems; lettuce and cabbage which are leaves; peas and beans which are seeds. Prove that the food stored in seeds, roots, stems and leaves will nourish new plants which will grow from these parts. Have the following materials: white potato, sweet potato, cabbage, lima beans, kernels of corn, wheat or oats, a glass dish, one glass jar with the opening at the top a little smaller than the large end of a sweet potato. Examine each of the vegetables and seeds and determine on what part of each plant a new plant will grow. Cut an eye from the white potato, leaving a piece of the potato attached to it. Plant an eye in the sand, with the eye part up. Keep the sand moist. Put the sweet potato in the jar full of water leaving the top of the potato above the water. Stand the cabbage with the cut end down in the glass dish. Place in a shaded spot. Pour water over the dish. Plant five lima beans in one pot of sand. Plant five of the other seeds in another pot. Keep them moist. Keep all of the plants in the room where they will have light. Observe them from day to day and record what happens.

3. Demonstration

Soak some bean seeds and some corn kernels overnight to soften them. Split the seeds and look for little plants. The tiny stems and leaves should be seen. Use a microscope if one is available. Test the seeds with iodine. Where is the food stored? Place the iodine in a medicine dropper to make this test. Notice that the bean has two parts while the corn kernel has one. All of a bean except the seed coat is the embryo. A corn kernel has a small embryo surrounded by an endosperm filled with starch. There is more starch in corn than in a bean.

CONCEPT - Fruits and vegetables are parts of plants.

1. Display pictures of fruits and vegetables. Identify them and let the children tell which fruits and vegetables are their favorites.

2. Bring in plastic models of fruits and vegetables. Arrange an attractive display around the room.

3. Plan to have a raw vegetable tasting party. Serve slices of carrots, celery, potato, lettuce, cabbage, kohlrabi. Notice the different tastes. Questions: Which vegetables taste better when cooked? Which vegetables do you seldom cook?

4. Bring fruits and vegetables from home. Discuss the importance of cleaning the fruits and vegetables before eating. Discuss similarities and differences in color, size, and shape.

5. Take a trip to the produce department of a grocery store. Call attention to: arrangement of food in display bins (in stacks, bags, boxes, bunches) foliage on beets, green onions, celery, carrots; no foliage on potatoes, apples, oranges.

6. Display pictures from seed catalogs showing fruits and vegetables growing on the plant. Match these with previous pictures.

7. Prepare a flannel board display. Let the children group the fruits and vegetables according to color.

8. Tell how the various fruits and vegetables are prepared by their mothers. Questions: How do they look or feel different after mother has prepared them? Do they taste different?

CONCEPT - Each part of a plant has its own work to do.

1. Bring in some entire plants, roots and all. Draw their pictures on the board. Label their parts. Children draw similar pictures in their science notebooks.

2. Visit a vacant lot. Notice the attachment of the plants to the ground and the upright position of most of them. Carefully remove several plants, roots and all. Try to make them stand as before. What happens? Take the plants home. Put them on the table for a day or two. What happens? Why?

3. Take two similar plants. (Use a plant which does not root from cuttings such as grass or plantain.) Pull one plant out of the ground; tear off the root section, and put the stem and leaves into a flower pot full of soil. Place both plants in a sunny window. Observe the results.

4. Take a potted bean plant. Cut the stem at ground level. Questions: What happens to both halves of the plant? What is the function of the stem?

5. Put two small plants on a sunny window sill. Remove and keep all leaves from one plant. Eventually, what happens?

6. Place a small plant on the window sill. Cover one or two leaves with aluminium foil. After about a week, uncover the leaves. Question: Why have the covered leaves lost their color?

7. Look for a flowering apple or peach tree in the neighborhood. Observe a few of its blossoms periodically. (Caution the children against destruction of blossoms.) Teach them to "enjoy but not destroy." Make some simple observations about the structure of flowers. Observe the tree again when the flowers have fallen off. Questions: What can you begin to see where the flowers were? What will happen during the summer and fall?

8. Bring some apples to school. Cut them open and give them to the children. Look for the seeds.

9. Find a patch of dandelions in a vacant lot or some open ground. Let the children each pick a blossom for classroom inspection. Be sure to leave some for future trips. Have the children take the dandelion blossoms apart. Notice the many flowers it has. Set up a hypothesis that flowers make seeds. Print it on a chart for future verification. Return to the plot when the dandelions have gone to seed. Bring back the dandelions heads. Question: Is the hypothesis correct?

<u>CONCEPT</u> - Water enters a plant through the roots by the process called osmosis.

1. <u>Problem</u>

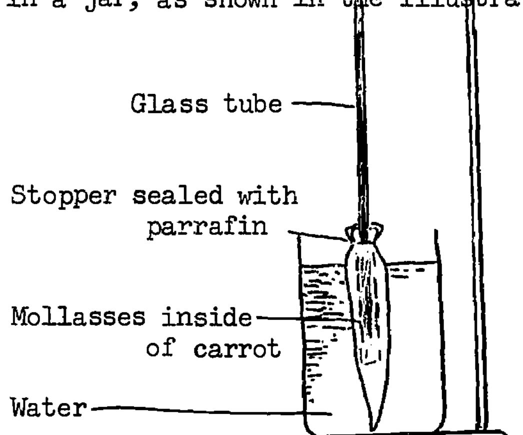
   How does water enter a plant?

   <u>Materials</u>

   Large carrot, molasses, jar, 1-hole rubber stopper, hollow glass tubing (about two feet long), paraffin, ruler or yardstick.

   <u>Procedure</u>

   Suggest to the children that a carrot can be used as a root to observe the passage of water into a plant. Using an apple corer, remove a section from the middle of the carrot. Be careful not to cut through the wall of the carrot. Obtain a 1-hole rubber stopper that will fit the hole cut in the carrot. Wet the stopper and carefully insert the glass tubing beginning at the wide end of the stopper so that the tubing extends about $\frac{1}{2}$ inch beyond the narrow end of the stopper. Pour molasses into the carrot, leaving enough room to insert the stopper. Then insert the stopper and tube into the carrot and support the carrot and tube in a jar, as shown in the illustration.



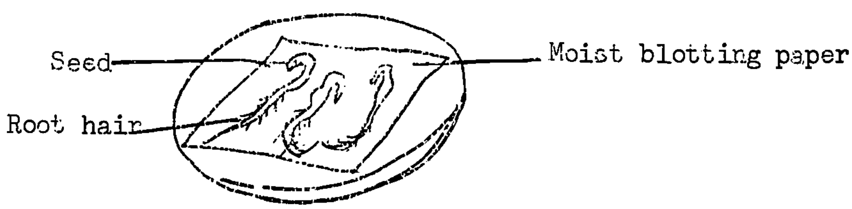
   Seal the stopper to the carrot with melted paraffin so that no leakage can occur. The paraffin can be applied with a small brush. Add water to the jar up to the top of the carrot.

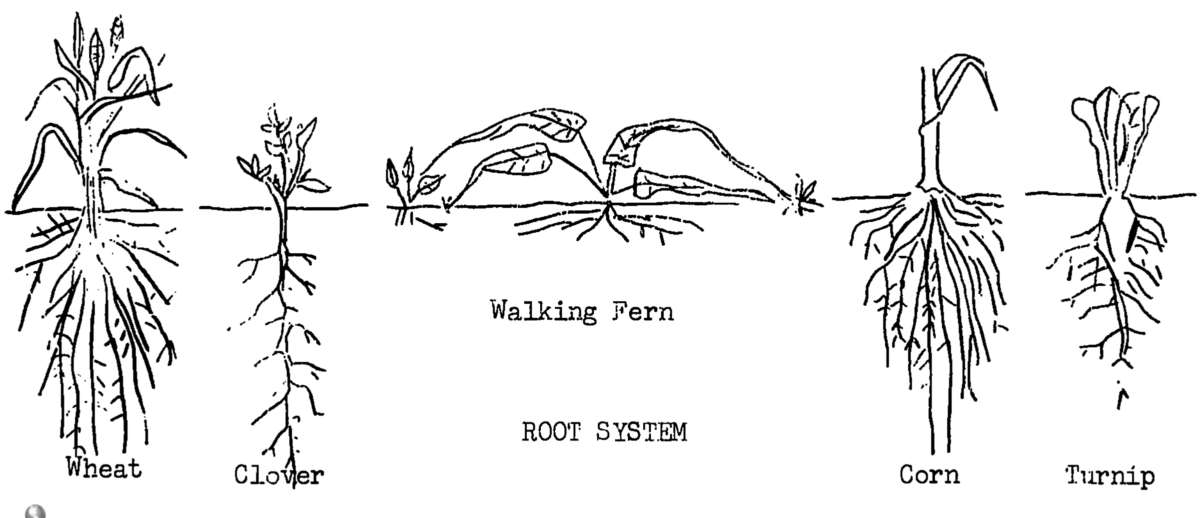
Ask the children how they will be able to tell if water is entering the carrot. (As the water in the jar enters the carrot the water mixes with the molasses, and the mixture rises in the tube.) The children could measure the height of the water in the tube at intervals of several hours and record their results. At some point the water will no longer continue to rise in the tube. At this point the water is entering the root with a force just great enough to hold up the weight of the water-molasses mixture in the tube. This force is called osmotic pressure and is one factor in explaining how water enters the roots of a plant and rises through the stems to the leaves.

To study the structure of a root, the children may wish to carry out the following activity. Obtain a shallow dish that can be covered with a sheet of glass and fit a piece of blotting paper at the bottom. Pour water into the dish, soaking the blotting paper, and then pour off the excess. Place several radish seeds on the moist paper, and cover the dish with the glass and place it in a dark warm place. Open the dish daily to let in air and to check the blotting paper to be sure that it remains moist. Add water if necessary to keep the blotting paper moist. After about a week, or when the roots are about 1 inch long, have the children examine the roots with magnifying glass. Tiny root hairs should be visible. The water for the plant enters through these fine root hairs.

<u>Results/ Conclusions</u>

Water enters the plant through the roots. The process by which water passes into the plants is called osmosis.





CONCEPT - Stems carry water from the roots to the leaves. Leaves retain some of the water, and they give off the excess water to the atmosphere.

1. Problem

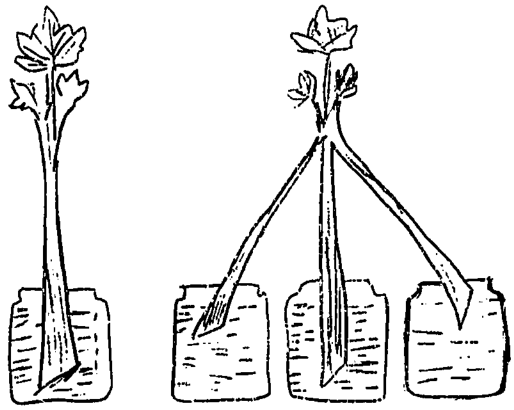
What is the role of stems and leaves in plants?

Materials

2 stalks of celery with yellow leaves, 4 glass jars, paring knife, water, ink or food coloring of three different colors (any colors except yellow and green are satisfactory), 2 leafy potted plants, such as geraniums, 1 roll of clear plastic wrap, 2 clear plastic bags large enough to hold the potted plants, string.

Procedure

Show the class the celery. Do they know what part of the plant the celery stalk is? (It is the stem, and it is a special kind of stem that stores food.) Now fill a glass jar with water colored with ink or with food coloring. (Enough coloring should be added so that the water is a good strong color.)



Cut diagonally across one stalk of celery near the bottom, and place the stalk in the jar containing colored water. Set the jar in bright sunshine.

Now make two cuts in a second stalk of celery, from the bottom of the stalk to within an inch or two of the top. The stalk will then be divided into three sections along most of its length, but the part that bears the leaves will be intact.

Fill each of the three glass jars with water of a different color. (For example, one could be filled with purple water, the second with red water, and the third with blue water.) Place each section of the stalk in a different jar, and set the jars in the sunshine. In a few hours have the children look at the leaves. (The first stalk of celery will now have leaves that are the color of the solution in the jar. The second stalk will have leaves of three different colors, matching the three colors in the jars.) Without removing the stalks, ask the children why the leaves are now colored. (They will probably guess that the solution in the glasses passed through the stalk to the leaves.) Ask the children if the stem (the stalk) itself changed color. (No.) Now remove the celery from the glass and cut across the stalks. What do the children see? (The celery "string" will be colored the same as the solution in which the stem was sitting.) Explain to the children that the "strings" are really tubes through which water is carried from the roots to the leaves. The tubes are somewhat like the blood vessels that carry blood throughout the bodies of people. Other plants have similar tubes in their stems.

Now ask the children what they think happens to the water when it reaches the leaves. They will probably have many ideas about this. Suggest that they can do another activity that will show them what happens to much of the water.

Show the children the potted plants. Remove all the leaves from one plant; the other plant should be left intact. Water both pots thoroughly. Then wrap clear plastic wrap around each pot, gather the the material at the top, and tie it closely with string around the base of the stem. Now place each of the potted plants in a plastic bag and tie the bag tightly at the top of the plant. Place both plants in a sunny spot.

Have the children examine the plants in an hour or two and ask them what they observe. (They will see that moisture has collected on the inside of the bag around the plant with leaves. Little, if any, moisture will appear on the bag around the leafless plant.) Ask the children where the water on the first bag came from. (It must have come from the leaves, since there is no water around the leafless plant.) What happens to the water that is absorbed by the roots of a plant? (It is carried through tubes in the stem of the plant to the leaves. The leaves give off water to the surrounding air.)

Some children may ask why the plant needs water. Through reading they will find that some of the water is used by the plant to make food. Food manufacturing takes place in the leaves. Water that is not needed by the plant is given off by the leaves.

Results/Conclusions

One of the functions of plant stems is to carry water from the roots to the leaves. The leaves use some water to make food. They give off excess water to the air.

2. Problem

What is the role of roots, stems, and leaves?

Materials

Glass, water, food coloring, bean plant.

Procedure

Put a bean plant in a glass of water that has food coloring or ink in it.

Results/Conclusions

The color can be seen in the leaves and the stem as it is carried from the roots up through the stems to the leaves.

3. Demonstration

Freshen a stalk of celery by standing it in the ice water for an hour. Then place it in water colored with red ink and set it in the bright light. When the leaves turn pink, scrape off the outer layers of the stalks until you come to the red lines. These are the vascular bundles colored with red ink from the water glass. At the base of the stalk, the bundles may be seen as red dots.

4. Split the stem of a white carnation. Put one part of the split stem in a glass of green-colored water, the other part in a glass of water colored red. The flower will turn green and red.

CONCEPT - Stems and leaves grow toward light, an adaptation known as phototropism. The part of a stem that exhibits the greatest amount of turning toward light is the growing tip.

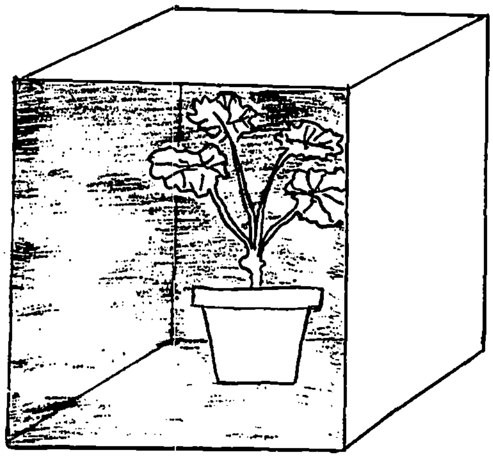
1. Problem

Does light influence the direction in which the stems and leaves grow?

Materials

2 seedlings (bean, pea, or sunflower), 1 half-gallon milk carton, black poster paint, felt-tip or marking pen, masking tape.

Have the children cut the bottom off a milk carton and paint the inside of the carton with black poster paint. If the children have studied the properties of light, they may be asked why the carton is being painted black. (Black absorbs light. Thus, most of the light that enters the carton will not be reflected onto all parts of the plant, which would affect the results of the experiment.)



Using a single-edged razor blade, the children should then cut a narrow slit, about 1 inch long and $\frac{1}{4}$ inch wide, in the side of the milk carton. (Caution. The slit should be level with the top part of the seedling.) When this small "darkroom" is prepared, the children may then mark with a felt pen a $\frac{1}{2}$-inch scale on each seedling, starting at the tip of the plant. At this point the children might want to make drawings or take photographs of the two plants before they are placed under experimental conditions.

Put the plants near each other in a well-lighted part of the classroom. Then place the carton over one of the plants and turn the slit away from the light source. So that no light will enter except through the slit, seal the carton to the table top or the ledge with masking tape painted black. The enclosed plant is the experimental plant, and the uncovered one is the control.

Both seedlings should be watered regularly by the children. The children can water the experimental plant by passing a rubber tube through the slit in the milk carton. After three days, remove the experimental plant from the milk carton and compare it with the control plant. The children may make drawings and compare them with the earlier drawing to discern any differences. Ask such questions as: What happened to the stem of the seedling in the milk carton? How does it compare with the stem of the experimental plant? What are the differences? How do the marks on the stems compare? What position did the leaves of the experimental plant assume? How do the leaves of the control plant look? Are there differences in the two sets of leaves? What conclusion can we draw from this experiment about the response of plants to light?

Results/Conclusions

Stems and leaves grow toward light. This response is called phototropism. The part of a stem that exhibits the greatest phototropic response is the growing tip.

CONCEPT - Roots grow toward water, an adaptation called hydrotropism. One of the important functions of roots is to absorb water for plants. Most of the water is absorbed by small hair-like structures called root hairs.

1. Problem

Do roots grow toward water?

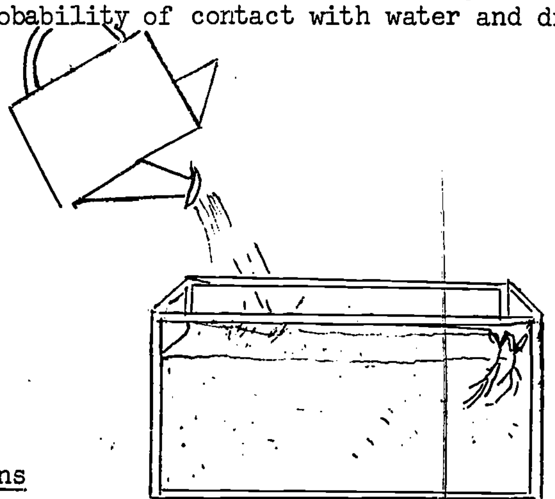
Materials

Radish seeds, glass aquarium about 2 feet long (do not use a round one), 2 flat pans about 2 feet long and 4 inches deep, potting soil, water.

Procedure

Fill the aquarium about 3/4 full with soil, packing loosely. Have the children plant about five seeds near one end of the aquarium next to the glass. The seeds should be placed about $\frac{1}{2}$-inch beneath the surface. Moisten the soil carefully so that it will not be too wet for successful germination. When the seeds have sprouted (within a few days), remove all but two of the plants so that the remaining ones will have room to grow and will be able to get plenty of nutrients from the soil. From this point, water the aquarium only at the end opposite that where the seedlings are growing. The end where the seedlings are growing will become dry.

For the next few weeks, have the children observe the plants. See if they can discover that the roots grow toward the watered end of the aquarium. When the roots are well developed and are obviously growing in the direction of the water, have the children dig up the plants very carefully to avoid tearing or damaging the roots. Have them examine the roots (a magnifying glass will provide better observation than the naked eye.) Ask them to describe what they see. (If the plants have been dug up very carefully, they should see tiny threadlike structures projecting from the roots.) Tell the class that these structures are called root hairs and that root hairs provide more surface for the diffusion of water into root. These root hairs push through air spaces in the soil, increasing the probability of contact with water and dissolved minerals.



Results/Conclusions

Roots grow toward water. Water is absorbed by small extensions of the root known as root hairs.

CONCEPT - In order to flower, a plant must receive a certain amount of light.

1. Problem

Does the length of time a plant receives light help determine whether or not it will flower?

Materials

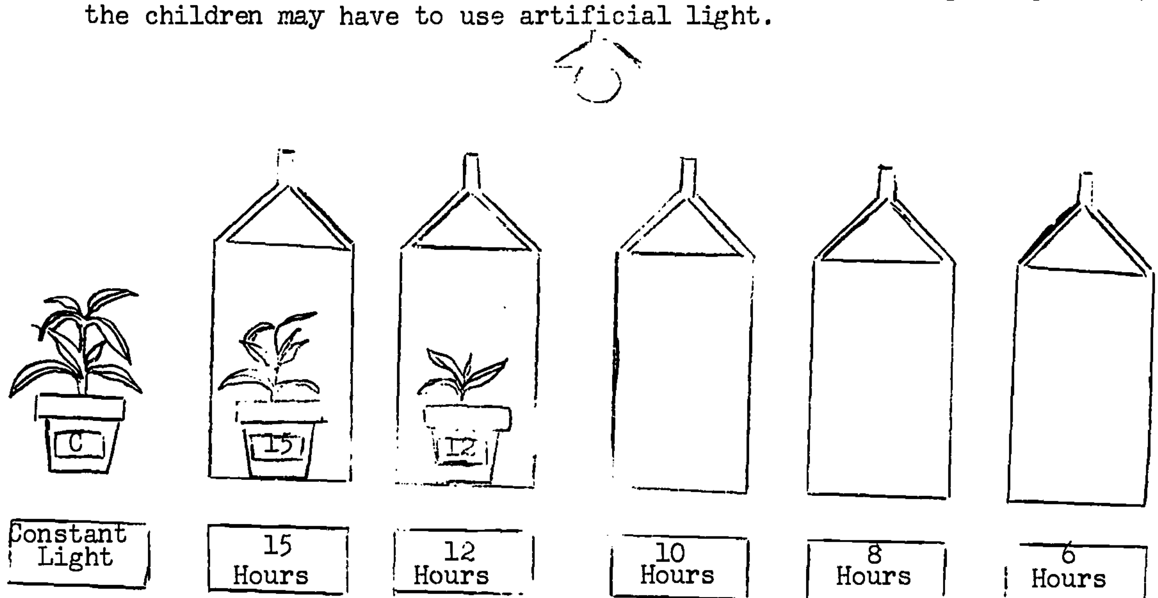
5 cardboard milk cartons ($\frac{1}{2}$ gallon or 1 gallon size), black poster paint, 6 potted plants (salvia, if possible), 100 watt bulb.

Procedure

The children can prepare a rather simple experiment to study how the length of exposure to light affects the flowering of plants. Obtain six potted seedlings, preferably salvia, one of the plants most used to demonstrate photoperiodism. Salvia seedlings may be purchased at a greenhouse, or the plants can be grown from seed in the classroom. When the plants are approximately 3 inches high, the children can carry out the following activity. Point out that until this point, all the plants have been receiving the amount of daylight normal to the season of the year.

Have the children paint the inside of the five milk cartons black. These cartons will be put over the plants to block out light. Then the children should determine the amount of sunlight your classroom receives. The time of sunrise and of sunset can be obtained from your local radio station or newspaper. The children will have to figure the number of hours between.

At this point you may discuss with the children how to plan the amount of light that salvia should receive. The recommended day lengths are 6 hours, 8 hours, 10 hours, 12 hours, 15 hours, and constant light. The day length may be controlled by covering each plant after it has received its recommended amount of light. For the 10-, 12-, and 15-hour light exposures, the children may have to use artificial light.



A 100-watt bulb should be used for this purpose. This activity should probably be carried out as a home project rather than as a classroom project, since many schools will not permit the use of electric lights after school hours.

The plant to receive 6 hours of light should be uncovered for only 6 hours during the day. The plant to receive 8 hours of light should be uncovered for only 8 hours per day, and so on. The plant receiving constant light should be placed under an electric light during the night.

Amount of Daylight	Date Experiment Begun	Did it flower?		Date Flowered	Number of Days Exposed
		Yes	No		
6 hours					
8 hours					
10 hours					
12 hours					
15 hours					
Constant					

Results/ Conclusions

The flowering of many plants is determined by the amount of time that the plant spends in light and in darkness.

CONCEPT - Green plants need air, light, warmth, and water in order to manufacture food.

1. Boil some leaves in water until they are soft. Place the leaves in a glass dish and pour some alcohol over them. Let them stand a few minutes, then pour the alcohol in a glass. Have the children tell what happens to the alcohol.

2. Soak a few beans in water overnight. Place them on a piece of moist blotter on a plate. Cover the seeds with a glass dish. When the beans sprout, the root hairs can be seen as fine fuzz growing sideways out of the main root. Have the children examine the root hairs with magnifiers and microprojectors.

3. Sprout small seeds on moist blotting paper and let the children look at tiny rootlets through a magnifying glass.

4. Plant beans in a pot of good soil; water and keep in a sunny place. Plant some other beans on a sponge in a small glass; be sure to keep the sponge wet and in a sunny place. Have the children observe and compare for a month to note which beans grow best and determine why this is so.

5. Place rich, dark soil in one box. Place sandy soil in another box. Plant grass in both boxes. Water and keep in a sunny place. Compare the planting several days later. Questions: Which grass grows best? Why?

6. Obtain two similar potted plants and do not water them for three days. Observe what happens. On the fourth day put aluminum foil around the base of one plant (over the soil in the pot so that water will run off and NOT enter the soil). Water each plant with one cup of water, pouring water over the stem and leaves of the plant with the soil covered. Label each plant indicating which part of the plant has been watered. After a few days observe what happens to the plant which has only its leaves and stem watered. Question: What does this show about the way plants get their water?

7. Mix a pinch of starch in one-half glass of water. Add a few drops of iodine. The mixture will turn blue or purple which shows the presence of starch. Try it on other foods, such as grated raw potatoes in water, salt, sugar, cooked rice, cornflakes, apples, bread. Green plants can change sugar to starch. Record the results.

8. Select two similar plants. Put one in a sunny spot, the other in a dark corner. Give each plant the same attention and care. Questions: Why do the leaves of the plant which was placed in the dark turn yellow? Which plant looks healthier? Why?

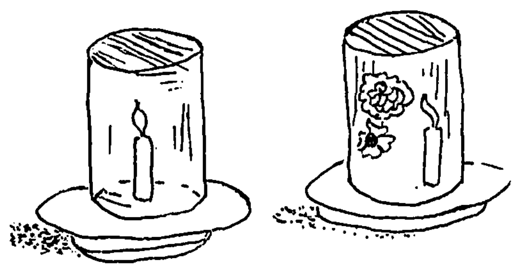
9. Plant some seeds in two flower pots; seeds that grow rapidly such as radish, bean or mustard seeds. When the seedlings are one inch high, cover one pot with a box that has a hole cut near the top. Lift the box from time to time and note the direction of growth. Rotate the box so that light comes from a different direction. After a few days, again check the direction of growth.

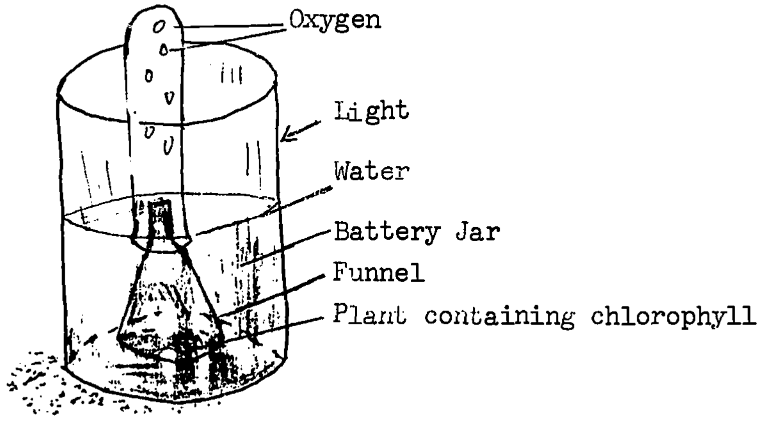
10. Place a plant in a box with a window cut in one end. Be sure no light enters except through the window. Observe for about two weeks and report the results to the class.

<u>CONCEPT</u> - In the process of photosynthesis, chlorophyll in green plants and radiant energy from the sun promote the combining of carbon dioxide and water to form carbohydrates and oxygen.

1. Demonstrate that plants give off oxygen in the presence of sunglight. Place a lighted candle on a glass plate and cover it with a large glass jar such as a battery jar. When the candle has gone out, raise the jar or glass slightly and insert a burning splinter of wood. The flame will go out, indicating that an insufficient supply of oxygen exists to support combustion. Now remove the jar, relight the candle, and place a growing plant beside the candle. Use grease or vaseline to seal the crack between the plate and jar. After the candle has removed enough oxygen so that it goes out, set the whole arrangement in the sun for one or two days. Again raise the jar slightly and test for oxygen with a burning splinter. The splinter will burn for awhile, indicating that the plant has given off oxygen.

2. Show that green plants give off oxygen in the presence of sunlight by using water or aquarium plants. Place water plants in a jar. Place an inverted funnel over the plants, and place a test tube in an inverted position over the stem of the funnel. Fill the jar with water until the funnel is completely covered. Place the jar in direct sunlight for three days. Remove the test tube and immediately insert a glowing splint of wood. The glowing splint will burst into flames. The presence of oxygen in the tube caused the glowing splint to burst into flames. Green plants give off oxygen in the presence of sunlight.





3. Demonstrate that plants manufacture food. Boil some leaves in water. Remove the leaves and place them in a beaker with some alcohol. Place the beaker inside a larger beaker which is about one-fourth full of water and heat over an electric hot plate. Observe. Remove leaves and test for iodine. Dark blue color will indicate the presence of starch in the leaves.

4. List and discuss the comparable features of a factory and a leaf.

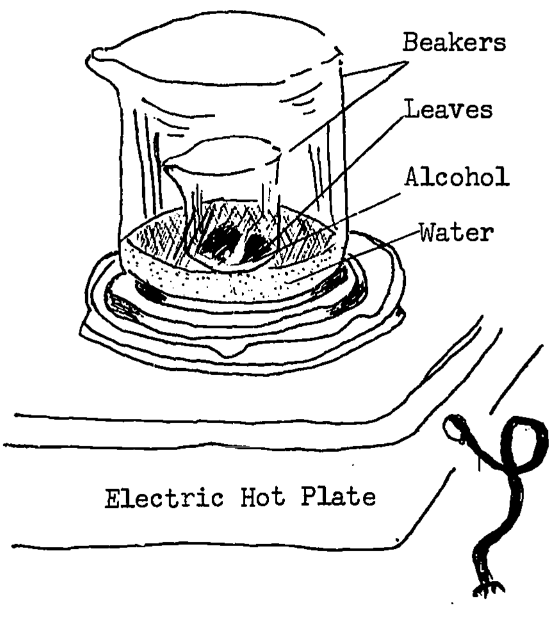
5. Study the following equation:

$$6\ CO_2 + 6\ H_2O \overset{*}{\text{-----}} C_2H_{12}O_6 + 6\ O_2$$

(carbon dioxide) (water) (sugar) (oxygen)

* This represents the reaction in the presence of sunlight and chlorophyl.

The above simple equation summarizes the chemical changes that take place.



CONCEPT - During the process of photosynthesis plants produce oxygen.

1. Problem

Do plants produce oxygen during the process of photosynthesis?

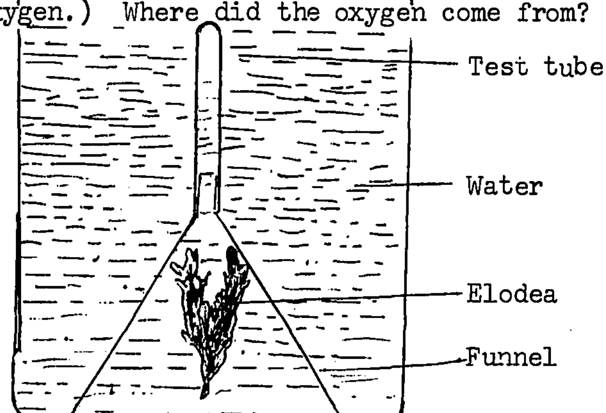
Materials

Bunch of elodea or other aquatic plant, battery jar (or 1-gallon wide-mouth jar), funnel, test tube, stand to hold test tube in inverted position, splints, matches.

Procedure

Fill the battery jar with water, and place the plants in the center of it. Cover the plants with the funnel inverted, making sure that the top of the funnel does not extend beyond the surface of the water. Fill the test tube with water, and place it over the opening of the funnel. Attach the test tube to the stand so that it is held erect. Be careful not to allow any air in the test tube.

Place the whole set-up in a sunny place for a day, and then have the children describe what happened. (At the top of the test tube is a space that was not there the previous day.) Call their attention to the tiny bubbles floating up in the test tube and ask them what these bubbles might be. (Bubbles of oxygen.) If they cannot see the bubbles ask them what the space at the end of the test tube may be filled with. (Oxygen.) Where did the oxygen come from? (The plant.)



How was the oxygen produced? (It was produced during photosynthesis.)

Suggest to the children that they test to see if the space is filled with oxygen. Explain that this can be done by inserting a glowing splint into the test tube and watching to see if the glowing splint burst into flame.

Carefully remove the test tube---the water in it will run out---and quickly stick a glowing splint in it. Be sure that you are still holding the test tube upside down and that the splint reaches the top. Ask the class to describe what happens. Why does the glowing splint burst into flame? (Because oxygen is present.) Where did the oxygen come from? (The plant.)

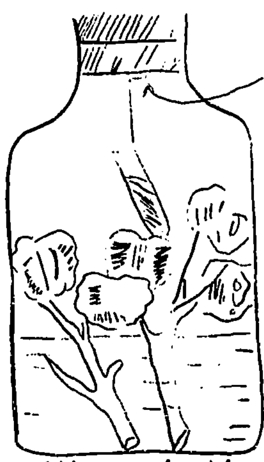
Results/Conclusions

During photosynthesis, water plants (as well as land plants) give off oxygen. One way of testing for oxygen is to see if a glowing splint will burst into flame.

CONCEPT - Plants use oxygen and release carbon dioxide in the process or respiration.

1. Demonstration

Place cut stalks from geranium plants in water in a large bottle or jar. Suspend a small test tube of limewater from the rubber stopper in the mouth of the bottle. Cover the jar with a cloth or place it in the dark for 24 hours. The limewater will become cloudy (release of carbon dioxide).



2. Contrast photosynthesis with respiration.

3. Discuss the difference between breathing (diffusion process) and respiration in plants.

4. Draw a chart depicting the carbon dioxide cycle.

5. Place a growing plant in a jar. Cover the jar tightly so that no air can get to it and place it in a dark place for two days. Then remove the cover and place a burning stick into the jar. The flame will go out. (Carbon dioxide puts out the flame. Since the jar was sealed, no oxygen could enter and no food could be made in the dark. The oxygen in the jar was used for respiration and carbon dioxide was released.) The plant would eventually die if not removed from the jar.

CONCEPT - All food comes from green plants directly or indirectly.

1. Name animals that provide man with meat: cow, sheep, pig. List the foods these animals eat. Discuss what would happen to these animals if there were no plants on earth. Question: Would man be able to use animals for food if no plants were growing on earth? Why?

2. Visit a market or grocery store near the school to learn the foods we eat which are part of a plant.

Roots	Leaves	Seeds
carrots	lettuce	beans
radishes	cabbage	peas
beets	spinach	
turnips	kale	
sweet potatoes	parsley	
	dill	

Stems	Flowers and Buds
onions	cauliflower
potatoes	asparagus
sugar cane	brussels sprouts

3. Make chart showing fruit. We get our fruit from trees, shrubs, and vines. The fruit is part of the plant containing the seeds.

Trees	Shrubs	Vines
cherries	raspberries	strawberries
peaches	blackberries	grapes
apples		watermelons
oranges		
pears		

4. Have a vegetable exhibit. (Fall is a good time.) If possible bring vegetables from gardens. Questions: Which part of each vegetable plant is eaten? Which one should actually be placed with fruit.

5. Plan a nut exhibit and see how many kinds of nuts can be brought into class. Arrange an attractive exhibit.

6. Bring materials for charts to display tree products used for food.

7. Look for fruit trees in the neighborhood. Observe them at different stages: when they are in bloom, when the fruits are ripe. Throughout the year keep a picture record of the changes in the tree.

CONCEPT - Plants differ from each other in structure and function.

1. Name as many kinds of plants as possible. List only the obvious differences (size, shape, color, habitat,) on the chalkboard. Discuss how these various characteristics may be important in grouping plants.

2. Read about Aristotle (384-322 B.C.) and Carolus Linnaeus (1707-1778) and their efforts to classify plants.

3. Define the words: botanist, classification, functional, phylum, chlorophyll, and pigment.

4. Discuss briefly the fact that all scientists do not agree on one system of plant classification.

5. Consult several resource texts which suggest plant groupings. Copy or list differences and/or similarities in the different sources. Conduct a discussion allowing the children to compare the results of their inquiries. Compare and summarize the current situation which exists in classifying plants.

6. Estimate the number of plants which have already been described by scientists. Question: Does this figure represent all plants? Why?

7. Stress that the traditional outline is used as an introduction because it permits a more simplified and convenient process involving a minimum of plant functions (physiology).

8. Summarize briefly the characteristics of thallophytes. Record the major similarities and differences within this group.

9. Read about and discuss the two subdivisions, algae and fungi.

10. Secure living specimens of algae. Existing school aquariums are usually an excellent source. Samples are also easily taken from lagoon, rivers, lakes, ponds, swamps, or may be obtained from biological houses. Examine specimens with hand lenses, microscopes and or a microprojector. Ask the children to examine individual cells. Questions: Are any dividing? Do some of the cells appear to be in special arrangements? Make sketches of the different combinations.

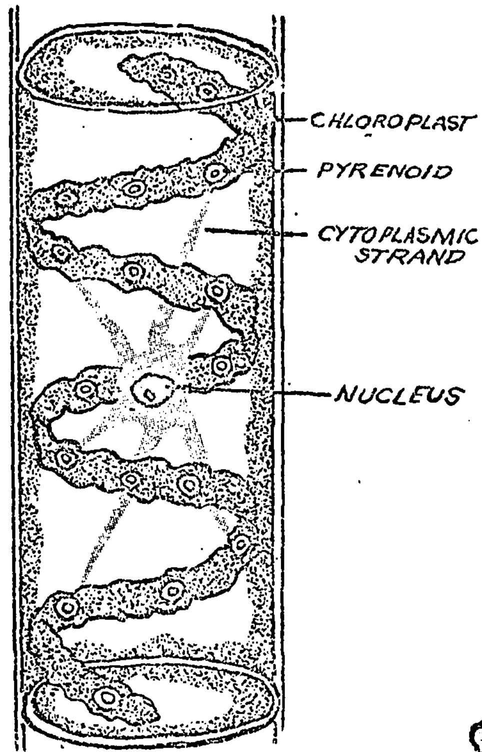
11. Develop a good working definition of algae.

12. Report on the different colors of algae. Suggest that the following questions as guideline. Questions: Do algae contain chlorophyll? What are the different colors found in algae.

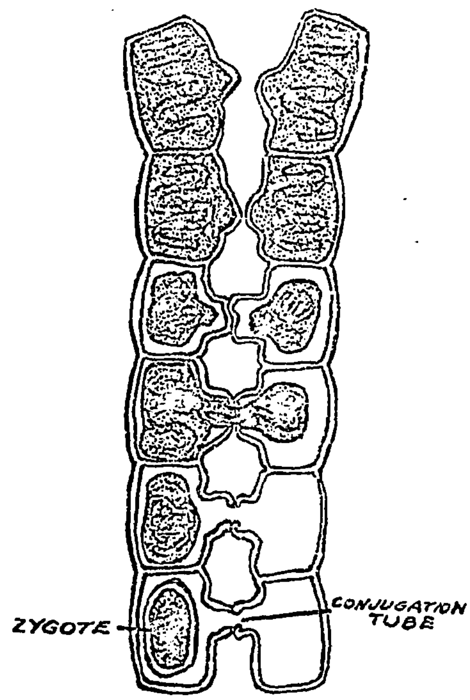
13. Demonstrate that oxygen is released by algae and/or other water plants during photosynthesis. Place a funnel over one of the water plants and collect the bubbles in a test tube for about 24 hours. Test the accumulated gas with a glowing wood splint. If the gas in the test tube is oxygen the splint will burst into flames.

Phylum Thallophyta
ALGAE

KELP



SPIROGYRA
A SINGLE CELL



SPIROGYRA
CONJUGATION

ULVA OR
SEA LETTUCE

14. Introduce the term parasitic. Relate it to fungi.

15. Read about the importance of fungi as both harmful and beneficial. Question: How may some fungi be dangerous? How may some fungi be helpful?

16. Show the growth of bacteria in milk and the effect of refrigeration on this growth. Fill two small, clean bottles with fresh milk and cover. Place one in a refrigerator and the other in a warm place. What happens in time - Why?

17. List some of the chemical products produced by or processed from fungi. Discuss penicillin in detail.

18. Grow some bread mold. Dampen a piece of bread and expose it to the air awhile. Place it in a glass jar, cover it, and place the jar in a warm dark, damp place. Examine it after a few days. The web-substance growing in the jar is mold. Examine a small sample of the mold under the microscope or microprojector. The mold threads and spore cases with spores can be seen.

19. Discuss some of the ways that fungi reproduce. Ask the children to look in their texts and other resource books for pictures of fungi reproduction.

20. Show the growth of yeast plants. Fill a test tube or small bottle about three-fourths full of warm water. Crumble a piece of yeast cake in the water. Add a teasponful of sugar as food. Lightly cork the tube or bottle. Shake vigorously until the yeast and the water are thoroughly mixed. Place in a warm location for a few hours. Questions: What happens? Does the cork pop out? Are there bubbles in the liquid? These bubbles are carbon dioxide. When yeasts decompose, they give off carbon dioxide.

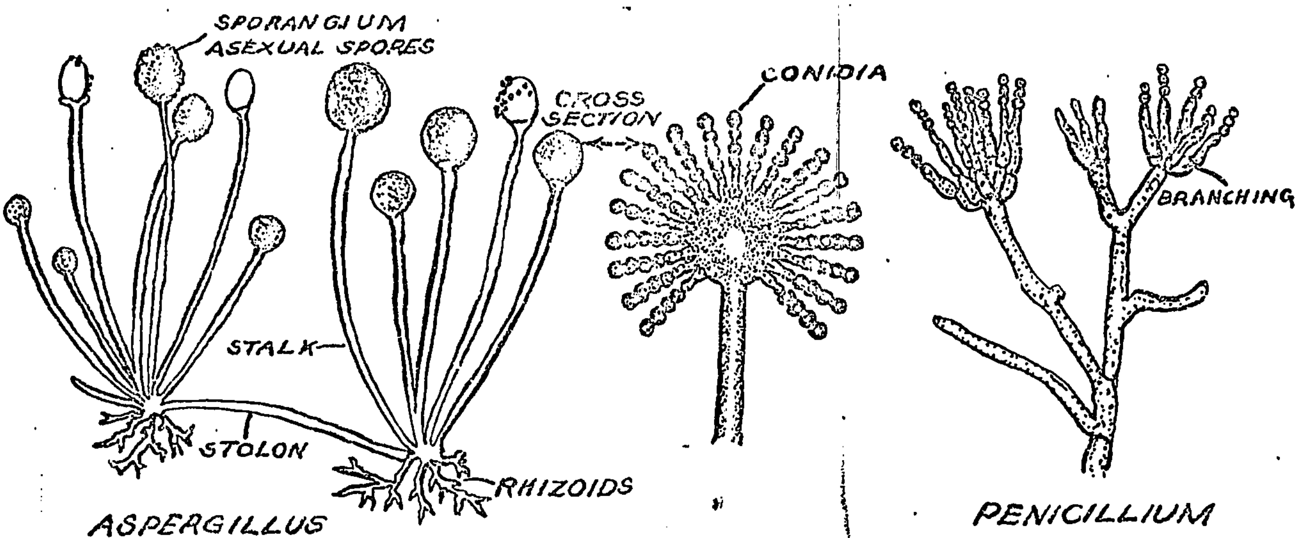
21. Repeat the same demonstration, replacing the cork with a balloon. Observe the results.

22. Use a microscope or a microprojector to examine small portions of the yeast mixture. Observe cell structure. Look for small buds.

23. Bring in different kinds of mushrooms and toadstools. Examine them under magnification. Questions: Is a toadstool different? How? Compare and explain.

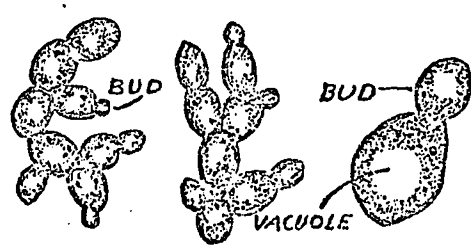
24. Consider lichens as a special group of thallophytes. Why? What are some of the problems that confront scientists when they try to classify plants.

25. Define the relationship which exists between some alage and fungi. Explain the possible advantages to each plant. Questions: Where are lichens commonly seen? Do some wild animals depend upon lichens as a food? What is "Reindeer Moss?"

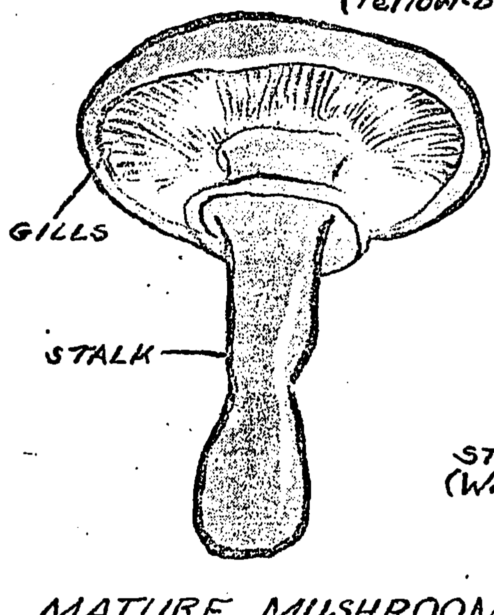


COMMON BLUE-GREEN MOLDS

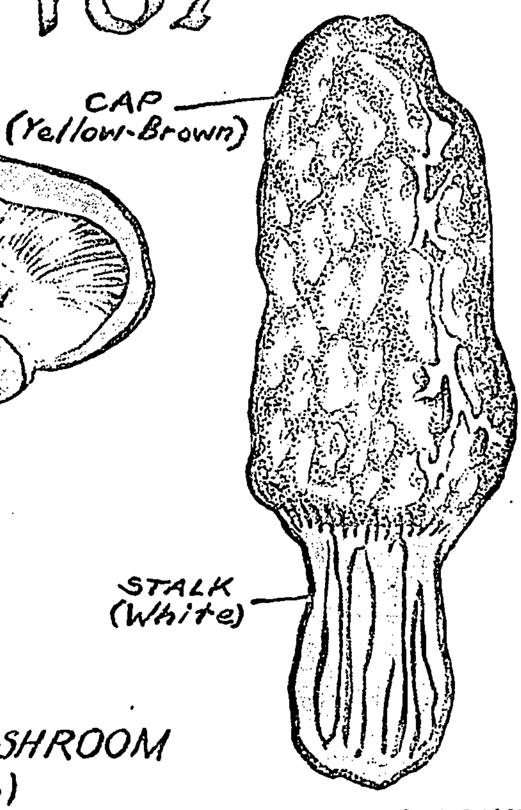
Phylum Thallophyta
FUNGI



YEAST-REPRODUCTION



MATURE MUSHROOM
(Cultivated form)



MOREL-MUSHROOM

DESTROYING ANGEL
(Poisonous Toadstool)

26. Introduce the term symbiotic to the class. Relate it to the term parasitic. Question: How are lichens different from algae? From fungi?

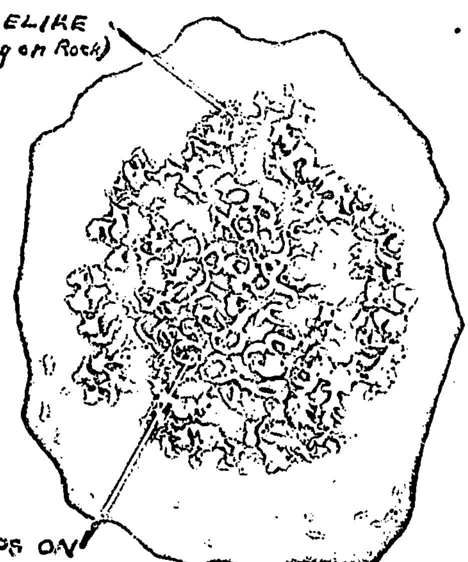
27. Summarize briefly the characteristics of bryophytes. Record the major similarities and differences within the group.

28. Collect as many different samples of mosses as possible. Let the children examine them under hand lenses, microscopes, and/or the microprojector. Look for the threadlike branches that serve as roots.

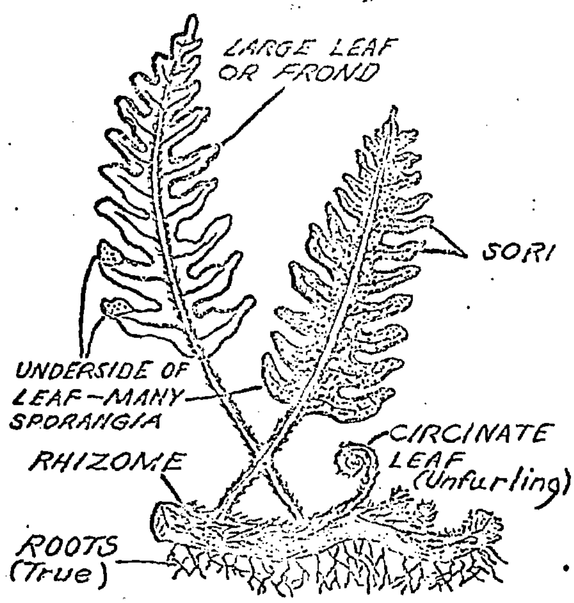
29. Use a potted, household fern. Notice the way its young leaves unfurl. Examine the veining of the leaves. Place part of a small fern leaf (upward) on a sheet of white paper. Observe closely with hand lens.

30. Examine some of the more common ferns available. Compare their similarities and differences.

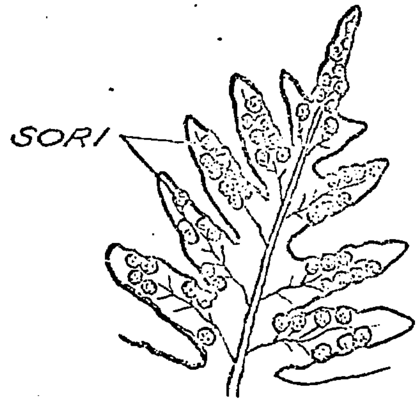
31. Identify horsetails. Note the jointed ribbed and furrowed stems. branches, and leaves in whorls.



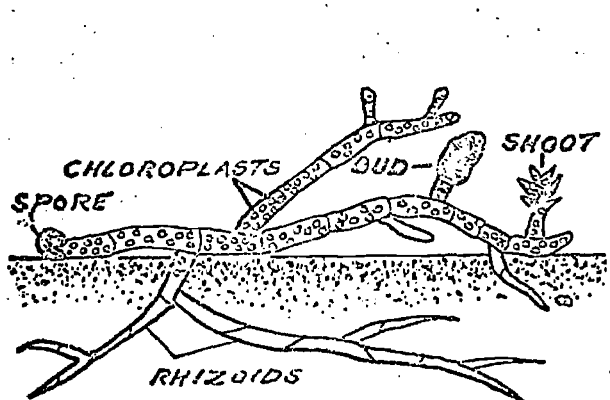
LICHEN
Growing on Rock



COMMON FERN



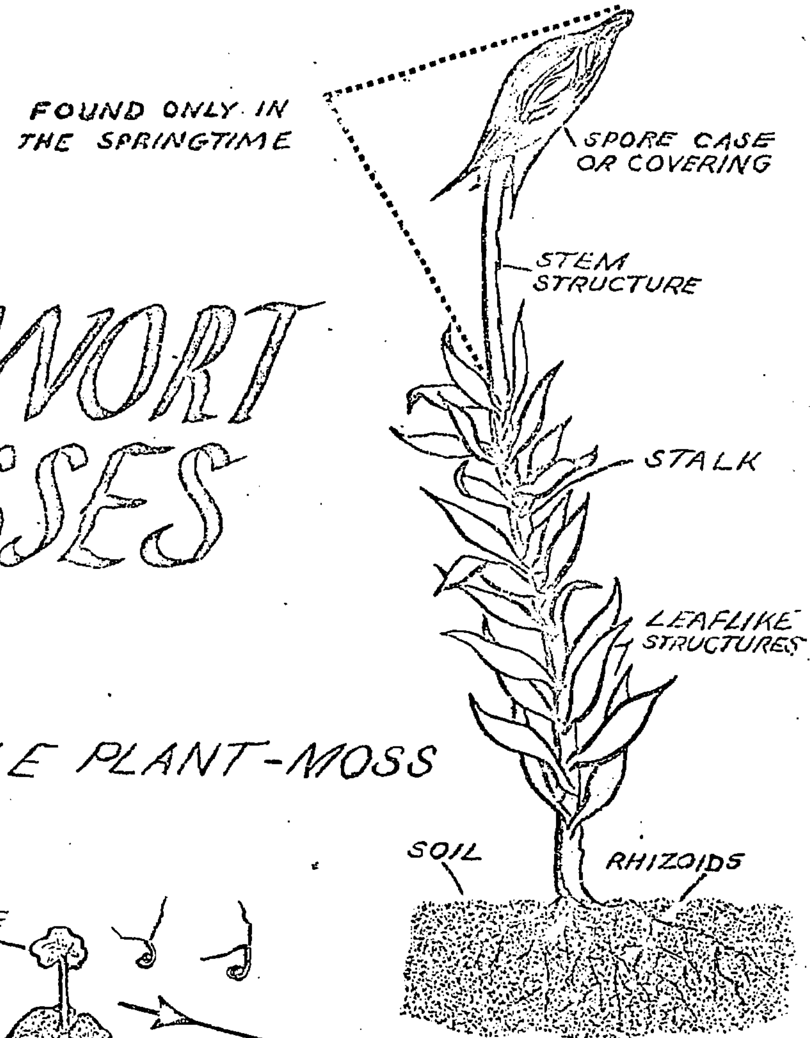
UNDERSIDE OF FERN



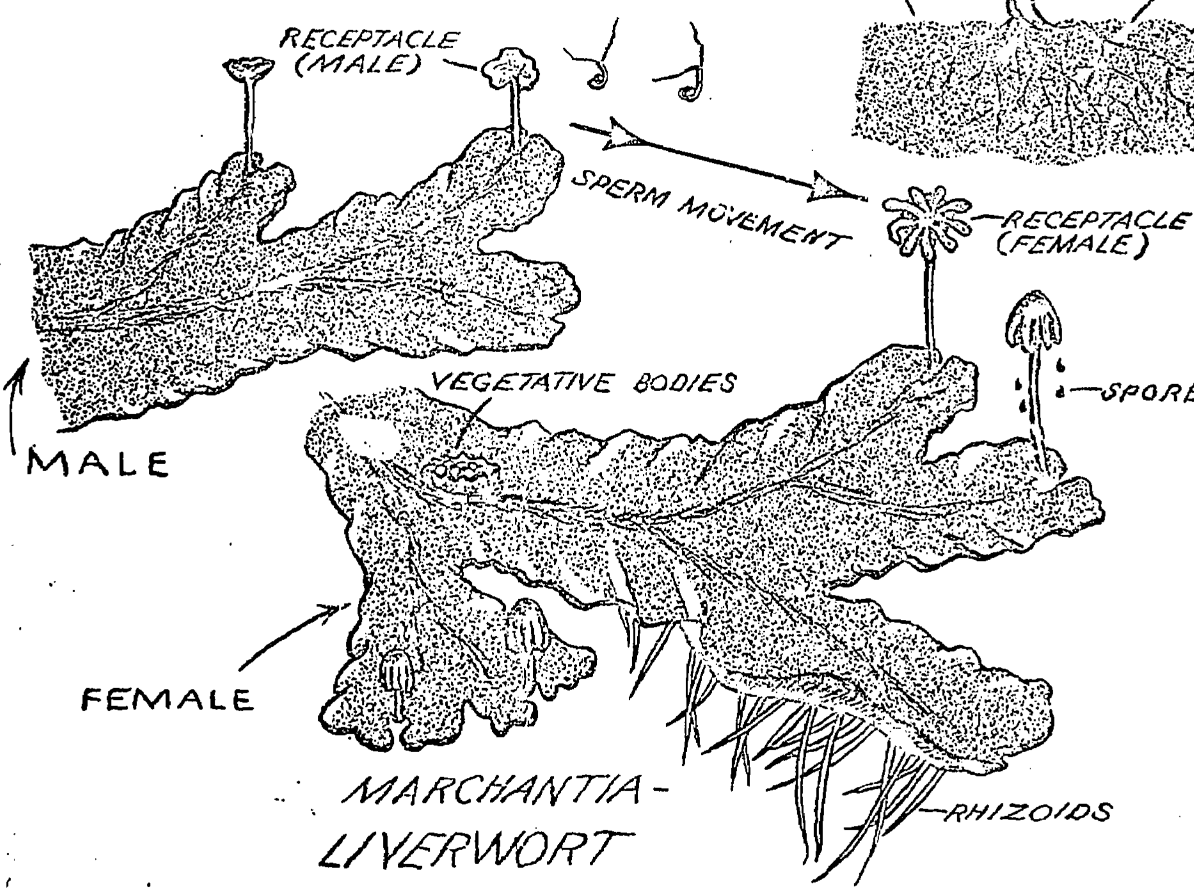
MOSS

Phylum Bryophyta

LIVERWORT and MOSSES



SINGLE PLANT-MOSS



MARCHANTIA - LIVERWORT

32. Compare spermatophytes with the other three divisions and encourage children to develop a good working definition of each.

33. Define gynosperm and offer some examples for class discussion. Secure some pine cones so that children may examine them more closely.

34. Discuss the structure and function of conifer leaves or "needles." Questions: Do the leaves carry on photosynthesis? Why? What are some advantages of this kind of structure?

35. Define the following terms: angiosperm, monocotyledon, dicotyledon, embryo, and vascular structure. Link these terms with examples where possible.

36. Make a list of some common monocots on the chalkboard. Discuss the most significant aspect of this group.

37. Review the ways in which plant seeds are transferred to different places. Group reports: air, water, ejection by plants, birds, animals, and man.

38. Examine the vascular system of a leaf.

39. Develop a list of dicots on the chalkboard. Question: What are the major differences between monocots and dicots. Develop a brief summary and working definitions for each group.

CONCEPT - Molds grow best in warm, dark places.

1. Problem

What are molds?

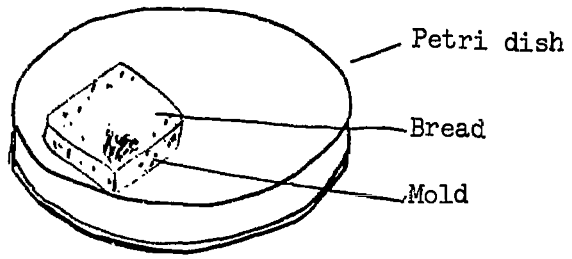
Materials

4 sterilized Petri dishes, 1 slice of moldy bread, 1 slice of fresh bakery bread cut into 4 equal pieces (kept covered until used), 4 cotton swabs, thermometer, medicine dropper.

Procedure

Sterilize the Petri dishes by washing them with a strong detergent and then heating them with their covers in place in an oven at 400° F. for about one hour. Remove the dishes from the oven carefully, keeping the covers in place.

The bread mold to be used may be obtained in one of two ways. A child may bring in a piece of moldy bread from home, or children may prepare it themselves by exposing a moist piece of bread to the classroom for about an hour. (It should be explained that home-made bread or bread made by a small bakery is best for this activity because packaged commercial breads contain chemicals that inhibit the growth of molds.) The bread is then put in a warm, dark, damp place for about four days. When the mold is black, it is ready for use. Have the children uncover the Petri dishes and place a piece of fresh bread in each one. Caution them not to expose the bread to the air for too long (to prevent contamination).



Using the medicine dropper, have one child place ten drops of water on each piece of fresh bread. Then, using a different swab of cotton for each dish, dust a small amount of the mold from the moldy bread on the bread in each dish. Place the lids on the Petri dishes, and put them in four different places. One dish can be put in a cold dark place such as a refrigerator. Another can be put on the window sill exposed to the sun's rays. The third may go any place in the classroom where it receives some light but is not exposed to the sun's rays and where it can be kept at room temperature. The fourth may be put in a warm dark place, such as a closet or a locker. The children can then make a chart on which they can record their observations and the daily temperature recordings. They should note the amount of growth, and the color of the mold. (The molds may assume various shapes, have various colors, and have an unpleasant odor.)

Ask the children why it was necessary to use the same amounts of water in each dish, why portions of the same mold were planted in the dishes, and why the same kind of bread was used in each dish. (Some of the conditions had to be the same so that they could know how the variable contitions---light and heat---affected the growth of the mold. Explain that this was how the experiment was controlled. All the conditions were the same except for the amounts of light and heat.)

Did the plants grow better in the location where they had more heat? (Yes, because in the cold places the plants' life processes were slowed down.)

Did the plants grow better in the location where they had more light? (Probably not, because since they are not green plants, they do not make their own food through photosynthesis, and hence do not need light.)

Results/Conclusions

Bread mold grows best in places that are dark and warm. It does not grow in places that are dark and cold. Bright sunlight does not help the growth of bread mold.

CONCEPT - Bacteria are microscopic nongreen plants that are present everywhere.

1. Problem

What are bacteria?

Materials

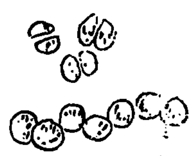
5 sterilized Petri dishes containing nutrient agar (obtainable from a science supply house), marking pencil or crayon.

Procedure

In performing the activity, the first dish is marked 1 and is kept covered at all times. This dish will serve as the control.

The second dish is opened and left uncovered for about half an hour. It is then covered and marked 2.

The third dish is put in front of a student who has just washed his hands very thoroughly. (Make sure that he does not contaminate his hands by touching his face, clothing, or anything else.) Have him touch his fingers to the agar and quickly replace the lid. This dish is marked 3.



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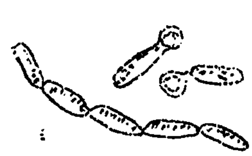
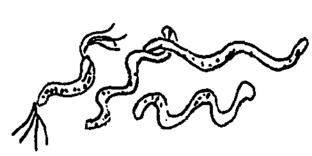


BACILLA



SPIRILLA

The fourth dish is given to a child who has not washed his hands. Have him touch his fingers to the agar and quickly cover the dish. This dish is marked dish 4.

The fifth dish is given to another child. Have him open the dish and comb his hair over it. This dish is then quickly covered and marked 5. Have one child keep a record such as that shown below.

Dish Number	Treatment	Description of Dish after 3 days
1	None	No growth
2	Uncovered in air	
3	Touched by clean fingers	
4	Touched by dirty fingers	
5	Hair combings added	

All five dishes (covered) are then put in a warm dark place for about three days. (Be sure to keep tops on all dishes.) Do not allow the children to touch, sniff, or in any way come into contact with the contents of the dishes.

When the cultures are ready, the children should examine them and note which contain larger colonies of bacteria. (All of the dishes may contain bacteria colonies. Dish 1 should have the least growth; it may not have any at all. Dish 2 should have some growth. Dish 3 should have some also, but less than dish 4. Dish 5 should have considerable growth.) Ask the class how the first dish served as a control. (It was prepared the same way as the other four, but was not exposed to bacteria as the others were.)

(Be sure to dispose of all cultures after this activity is completed. First flood the surface of each dish with Lysol, or a 5% solution of cresol. Let the solution stand for about half an hour and pour off. Empty the dishes into a newspaper, and burn it in an incinerator. Do not touch cultures. Wash dishes in a strong detergent as a further safeguard.)

Results/Conclusions

Bacteria are present everywhere. Many of the bacteria present on a person's hands can be removed by thorough washing.

CONCEPT - Yeasts are tiny nongreen plants and, like other nongreen plants, do not make their own food. When yeasts feed on sugar, in the absence of air, they form carbon dioxide gas and alcohol, in a process known as "fermentation."

1. Problem

What are yeasts?

Materials

Cakes of yeast, measuring cup, 2 jars, rubber glove, sugar, water, tablespoon.

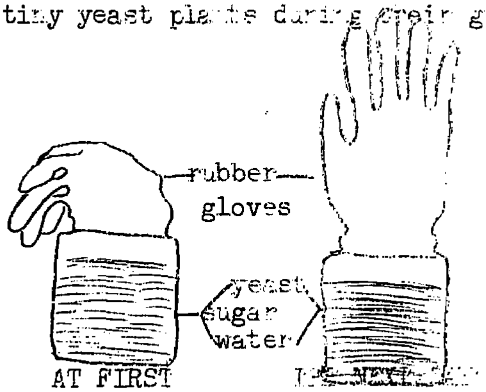
Procedure

Have a student crumble a yeast cake and dissolve it in a glass of water. Warm water should be used if it is available. Have another student prepare a sugar solution by dissolving about 4 tablespoons of sugar in about 2 cups (16 ounces) of water. Be sure that all the sugar and yeast are dissolved.

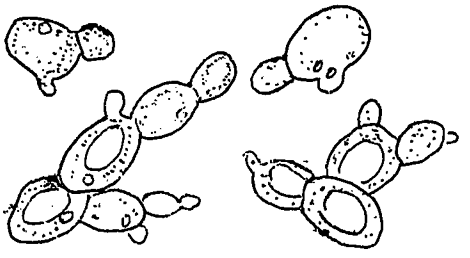
Into each of two jars pour about half the yeast solution and about 1 cup of the sugar solution. Stir each mixture well. Cover one of the jars with a piece of cardboard. Fasten the rubber glove tightly over the mouth of the second jar, holding it in place with a rubber band. Leave both jars in a warm place for one day. Yeast must be warm in order to grow and react with the sugar.

The next day have the class examine the jars. (The solution in each jar should be cloudy and have rising bubbles. The rubber glove should be inflated.) Explain to the class that the bubbles in the jar are carbon dioxide gas and that the glove was inflated by the carbon dioxide that was produced when the yeast reacted with the sugar.

Have the class uncover the first jar and sniff the solution carefully. Ask them what they smell. (Alcohol. The brewing and distilling industries use yeast to make alcohol.) Remind the class that the reaction they have just observed is called fermentation. Write the word on the chalkboard, and ask a child to write its definition on the board after he has checked it in a dictionary. (Fermentation is caused by the tiny yeast plants during their growth.)



Some children may ask what happens to the alcohol and carbon dioxide during the baking process. During the baking process, the alcohol evaporates. The carbon dioxide produces bubbles that remain in the bread dough as the "air holes" that make bread spongy.



Yeast Cells

Results/Conclusions

Yeast reacts with sugar to produce a gas (carbon dioxide) and alcohol. This process is called fermentation. Fermentation is the process that causes dough to rise. It is also the process used to make alcohol.

CONCEPT - Mushrooms are nongreen plants that produce new plants like themselves by means of tiny structures called "spores".

1. Problem

What are mushrooms and how do they reproduce?

Materials

Mushrooms (fresh, preferably obtained from a grocer), knives, sheets of white and black paper, wide-mouthed tumblers or glass candy dishes.

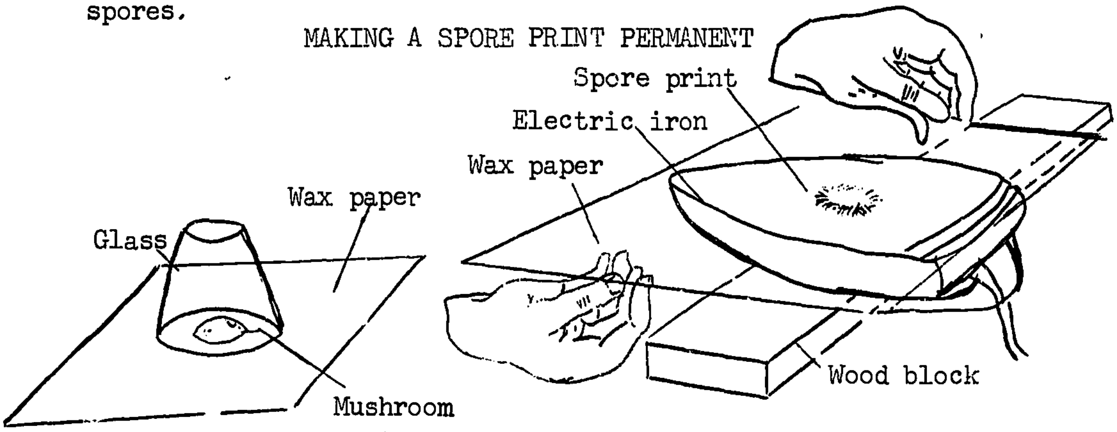
Procedure

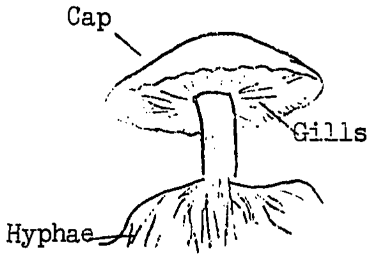
Distribute a number of mushrooms to the class and have the children examine them. (Instruct them to be careful and gentle, as mushrooms break easily.) Tell them that the umbrella-shaped top is called a cap and the rest of the plant the stalk. The cap is the reproductive organ, and the stalk supports it. The part of the plant concerned with obtaining food and water grows below the ground. Only the reproductive part grows above ground. Discuss how this adaptation helps spread the species.

Have the students cut the stalk close to where it joins the cap and turn the cap over. On the underside of the cap the children will see numerous, thread-like structures that are arranged like the spokes of a wheel. These structures, called gills, produce the tiny spores that grow into new mushroom plants. Explain to the children that spores are not usually seen because they are so tiny and because the wind blows them from the plant. The spores serve the same function as seeds do. It can be added that mushroom plants "spread" through an area by means of the spores.

Distribute other fresh mushrooms to the class, and have the children gently cut the cap from the stalk as before. Have them place the caps, rounded side up, gill side down, on pieces of wax paper. Have each child cover his mushroom cap with a wide-mouthed tumbler or a glass candy dish. The glass will prevent the spores from being blown away. Leave this arrangement undisturbed until the next day.

The next day have the class remove the glass covering and gently lift the mushroom cap. Upon examining the wax paper beneath the cap, the children will find a powdery pattern. Some children may find whitish, black, purplish, or brown spores. If they question this, explain to them that different kinds of mushrooms produce different colored spores.





The pattern left by the spores is called a spore print. The tiny particles making up the prints are the spores. The pattern is determined by the arrangement of the spore-producing gills on the underside of the cap. To make their spore prints permanent, the children may heat the wax paper with an iron set on low. The spores will settle into the melting wax. Each print may then be mounted on colored construction paper for contrast. For example, white spore prints will show up nicely on black or purple construction paper.

Results/Conclusions

Mushrooms, like other nongreen plants, obtain their food from other organisms. They do not make it themselves. Mushrooms reproduce by making tiny bodies called spores, each of which can grow and develop into a new plant like its parent.

CONCEPT - Plants are important to water and soil conservation.

1. Review the terms resources, reclaimed resources, erosion, and conservation.

2. Investigate the local, state, and federal agencies dealing with preserving natural resources.

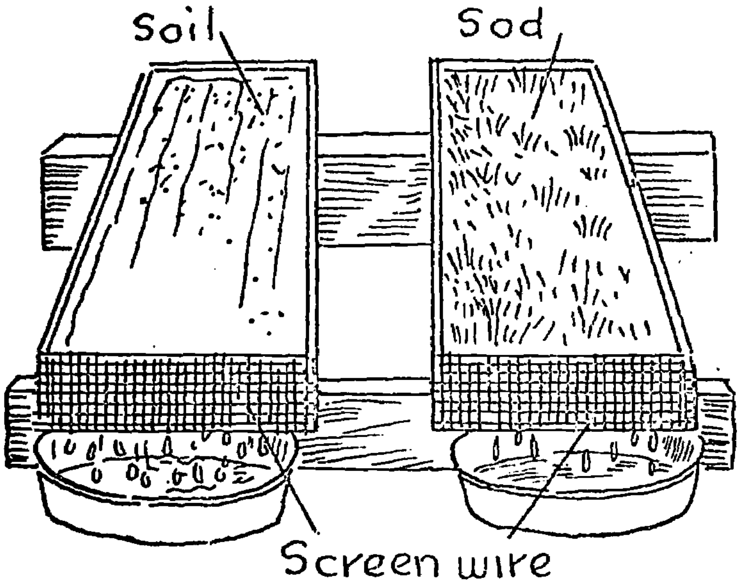
3. Discuss some of the methods used to prevent soil erosion, such as reforestation, windbreaks, contour planting, dams, dikes. Read about and discuss the dust bowls of the 1930's.

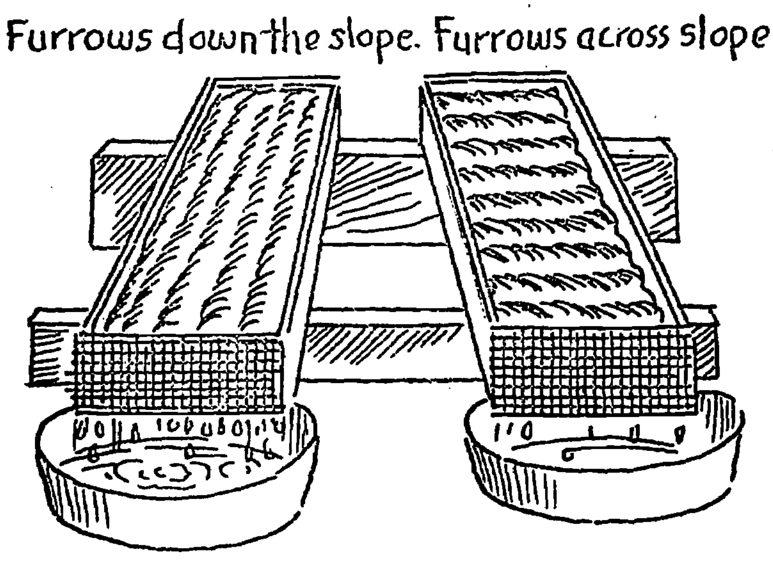
4. Demonstrate the water-absorbing qualities of a grass-covered slope as opposed to a barren slope. It can be easily demonstrated by using a blotter and wax paper. Arrange the blotting paper and waxed paper on two sloping boards. Pour equal amounts of water on each slope. The water will be absorbed by the blotter but the waxed paper slope will quickly drain. Question: Which paper represents the protected (planted) slope and which one represents the barren slope?

5. Make two trays (open at one end) and place a piece of screening on one end of each tray. Fill one tray with fine soil and the other with soil and grass. Tilt each tray equally so that it forms a slope. Sprinkle each tray with equal amounts of water. Catch the residue with containers. (Be sure that the screen ends are directly above the pans.) Questions: Which tray loses the most water? Which tray loses water more rapidly? Why is soil conservation becoming more important each day.

6. Use the same apparatus described in the preceeding activity; however, fill each tray with packed soil. Use a pencil to make furrows up and down the slope on one tray and across the slope in the other. Sprinkle equal amounts of water on each tray and collect the residue and water. Questions: Which tray retained the most water? When plowing a hill or slope why should a farmer plow cross furrows? In what way would trees and grass help?

CONSERVATION OF SOIL





CONCEPT - Trees are the largest and among the oldest living plants.

1. Discuss that it has been possible to trace the history of tree development from fossils obtained from coal formations. Question: What is coal?

2. Discuss the first trees; later read about them. Question: How do present and early trees differ?

3. Read stories and collect pictures of the sequoias (giant redwoods). List the most outstanding features of this tree group. Display the pictures.

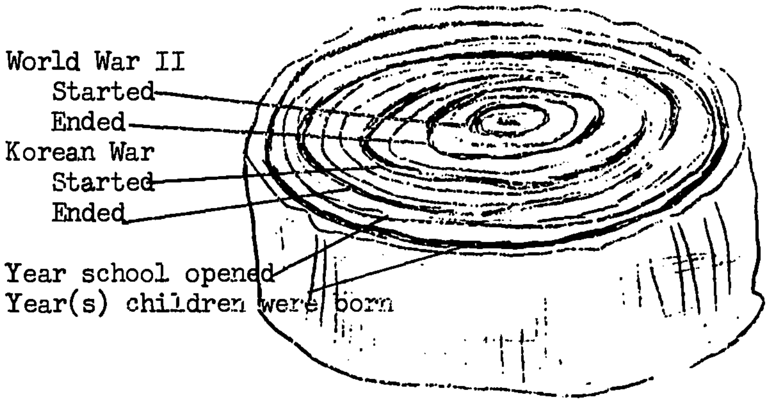
4. Discuss annual rings of trees and how they reveal important information to man.

5. Obtain a round piece (cross-section) of firewood or a log. Count the annual rings, and indicate the following at the annual ring appropriate to the statement: The year World War II started, the year it ended; the year your school was founded; the year or years in which the children were born. Drive a nail or tack into the approximate annual ring and attach a string to it.

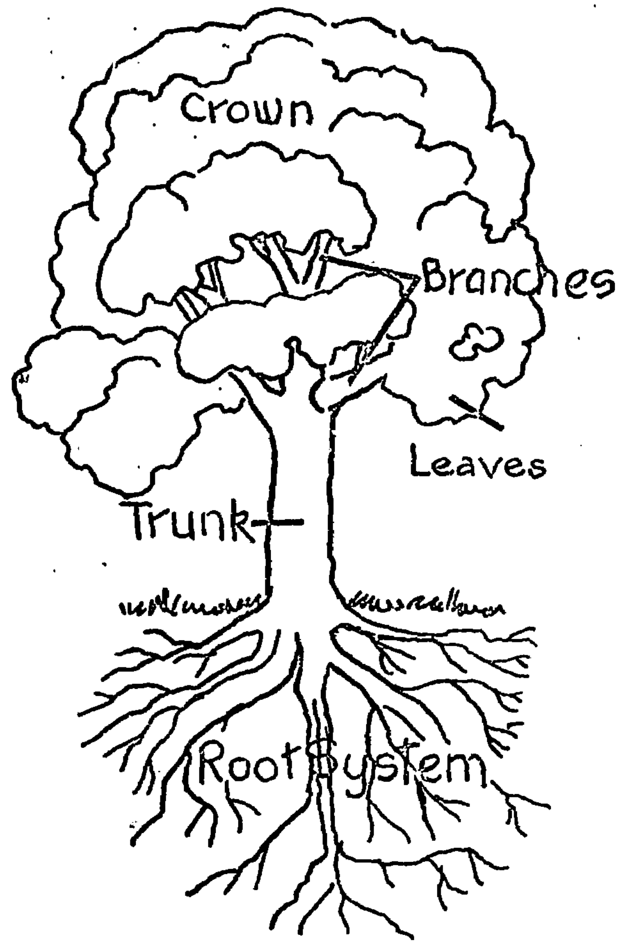
6. Read and find as much information about the protective bark advantage of redwoods and bristlecones.

7. Discuss the bark differences of trees located in the school community. Question: Does the age of a tree seem to alter its appearance? Discuss the changes in appearance of trees planted by the parents, grandparents, and friends of the children. Take the class into the community to see trees.

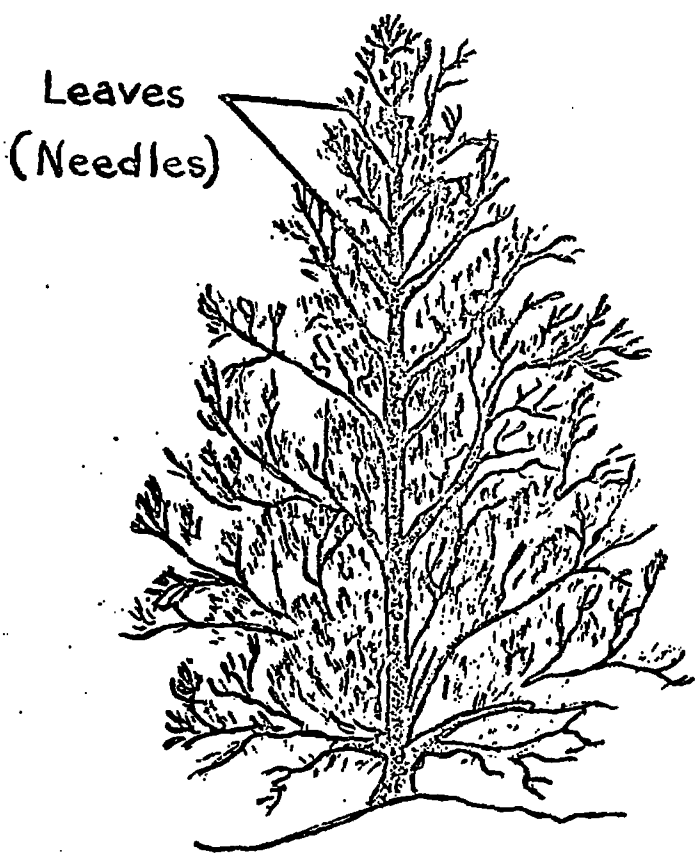
8. Find samples of redwood in homes or neighborhood buildings. Write a report on one of the questions listed below. Questions: In what way is redwood generally used? Does redwood seem to withstand weather conditions well?



TREES
Deciduous and Coniferous

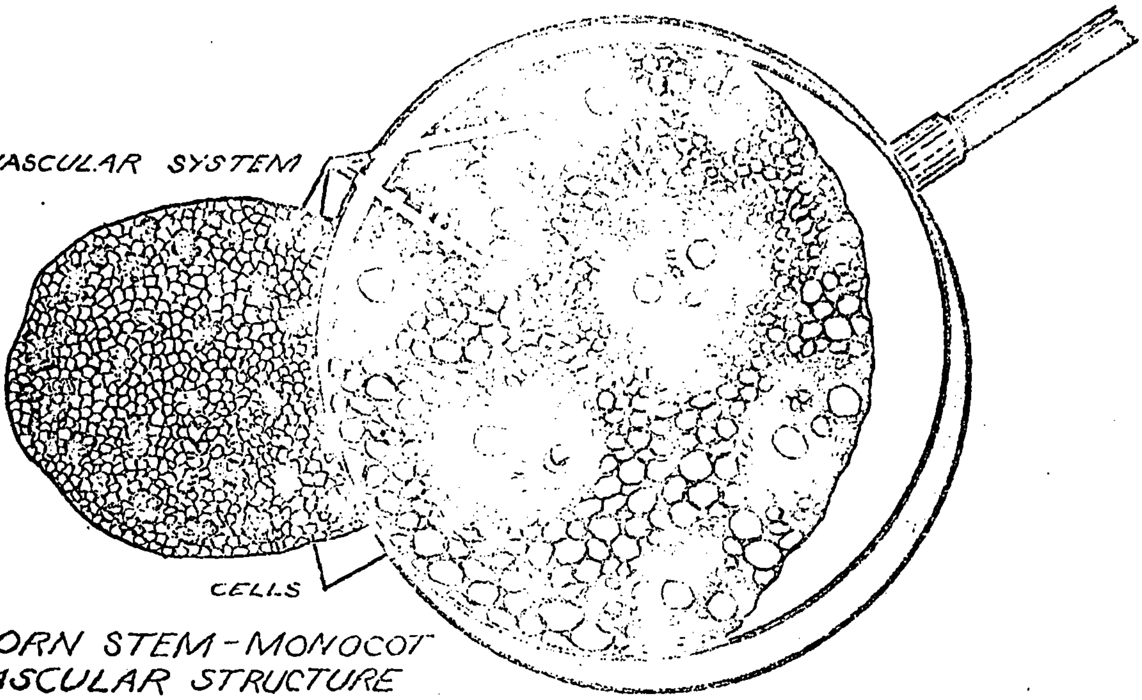


DECIDUOUS TREE

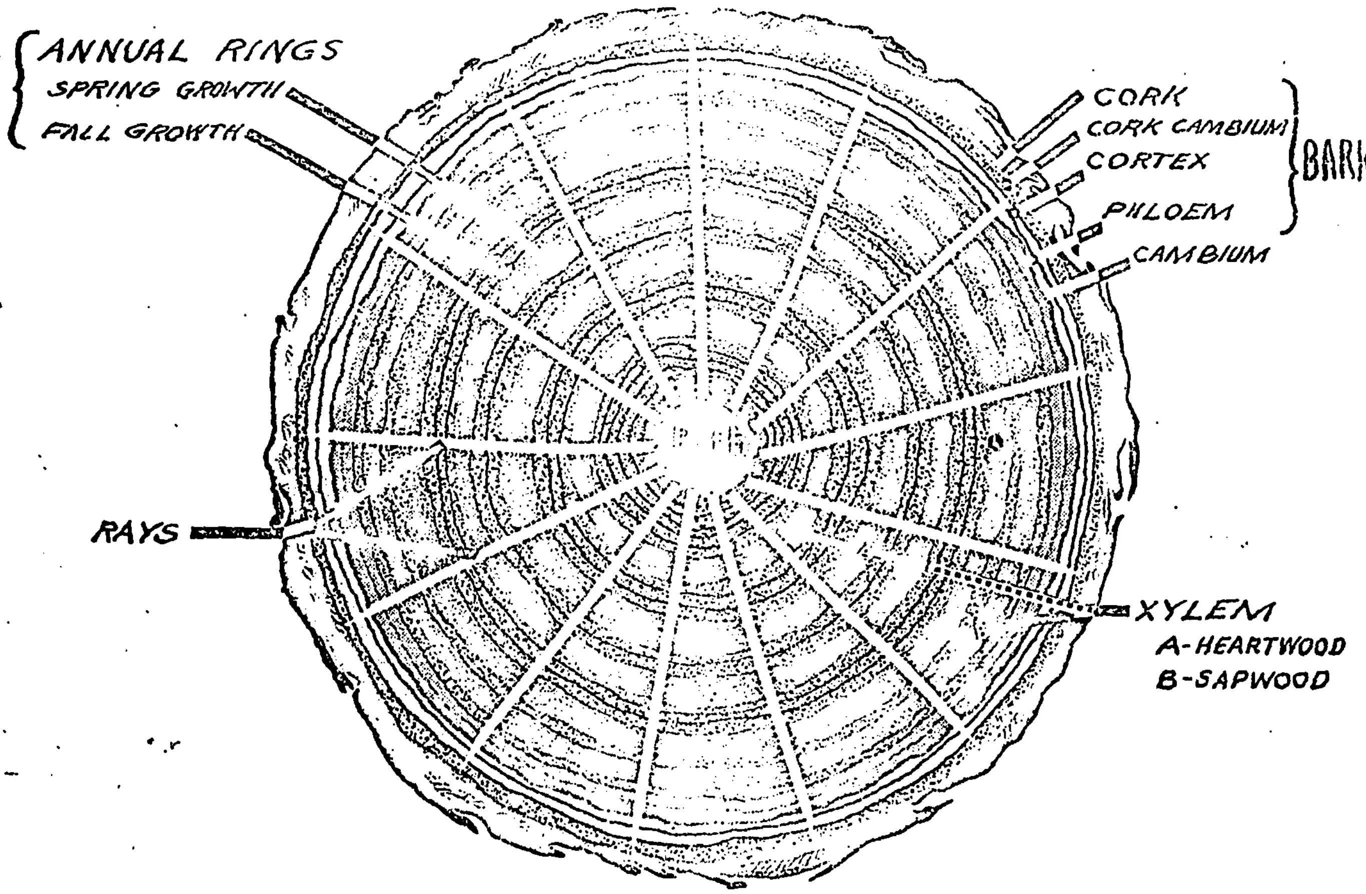


CONIFEROUS TREE

55.



CORN STEM - MONOCOT
VASCULAR STRUCTURE



YOUNG OAK TRUNK - DICOT

CONCEPT - Trees are commonly divided into two groups: those that lose their leaves in autumn, and those that do not.

1. Compare trees with other plants that lose their leaves in autumn. Question: What is the big difference between most of them?

2. Look up the word deciduous, conifer, and dormant. Discuss their meanings in class and attempt to get a brief "working definition" for each.

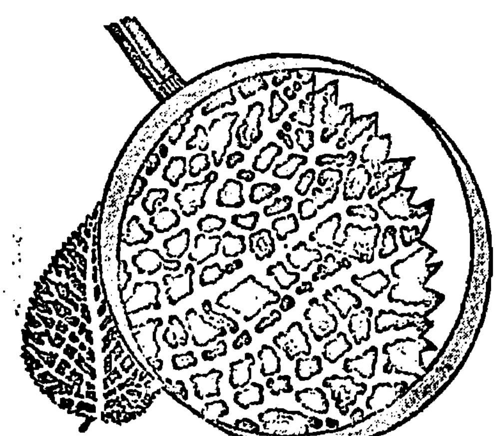
3. Go on a nature hike within the school area to view seasonal tree growth. Question: Do the deciduous or conifer trees show the greatest leaf development?

4. Count the number of evergreen and broadleaved trees on the way home from school. Question: Which group dominates?

5. Relate the basic differences between softwood and hardwood trees. Identify as many as possible. Examine the furniture in the classroom and associate it with certain trees. Question: Is most of it hardwood? Why?

6. Discuss and interpret the influence of surface area upon evaporation of water from a leaf. Point out the major differences between deciduous and conifer tree leaves. Explain how these differences affect tree growth and color.

7. Place equal amounts of water in two drinking glasses. Put a sponge in one glass until all the water is absorbed. Apply this to a large area of the chalkboard. Note the great differences in time of evaporation between the water in the remaining glass and that which was applied to the chalkboard. Relate this to the activity above.



AMERICAN ELM
Netted Veins

CONCEPT - Trees differ from each other in characteristics of growth, structure, and reproduction.

1. Develop a good working definition of a "conifer" and "deciduous" tree. Include in the definition as many features as possible.

2. Review the physical structure and functional aspects of trees.

3. Read about and discuss the function of stems.

4. Locate information about maple syrup. Question: Where does it come from? How deep into the bark does a person bore?

5. Discuss the functions of the xylem and phloem.

6. Collect pictures of trees showing the different shapes and types. Contrast the graceful shape of an American elm with the horse chestnut. Observe the round, full crowns of the maple, and the drooping contours of the willows.

7. Obtain several leaves and note their differences in size, shape, edge, texture, color, and stem arrangement. Make a classroom leaf collection.

8. Develop a chart using these titles as guides: Leaf Size, Shape, Edge, Colors, Texture, Stem.

9. Make a display board covering six of the most common trees in the school area. Include drawings of leaf, bark samples, twigs, flowers, fruit, and seeds of the trees.

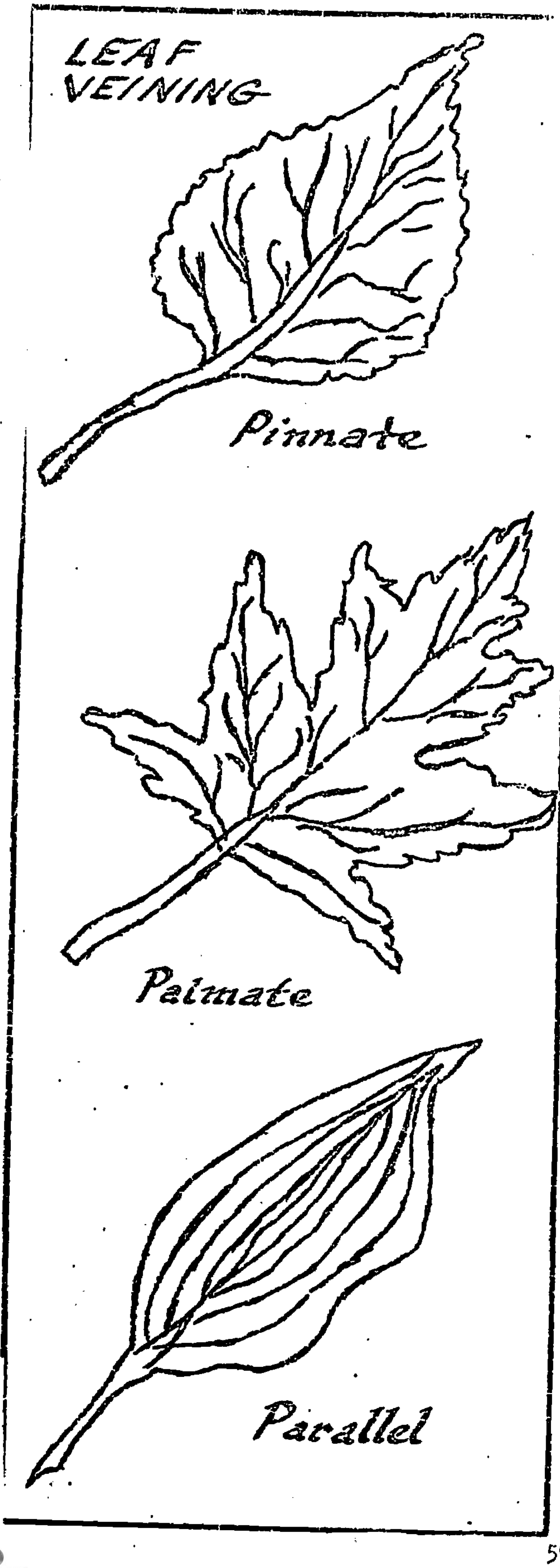
10. Select one tree for a study project and encourage children to become as much of an authority as possible from reading and personal observations of living parts (use of micro-projector and/or microscope). Relate the findings of the children to growth, structure, and reproduction in different tree types.

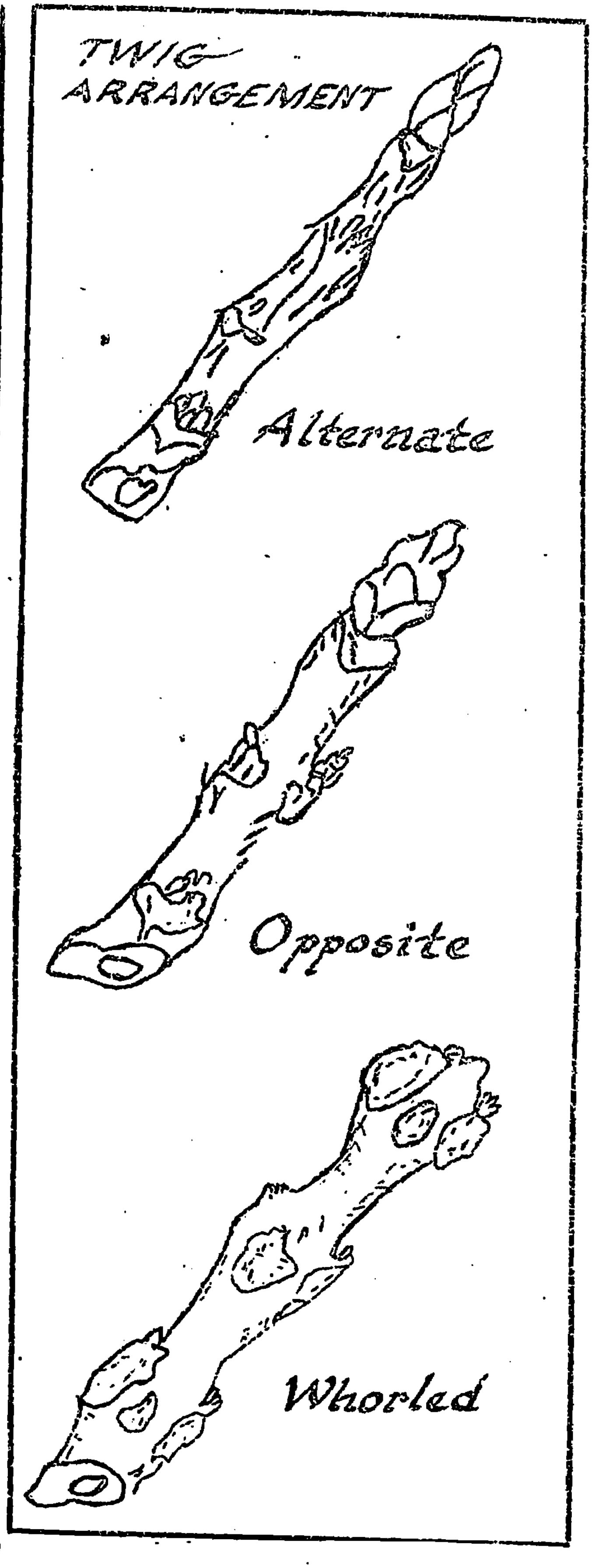
11. Read about and discuss the root systems of trees. Include information about root structure, size, and function.

12. Talk about the dependency of roots on other plants.

13. Start a research project to study root growth and functions. (Encourage them to use transparent containers.)

14. Plot the location and kinds of trees found in your neighborhood, or school district, on a large map. Set up committees to apportion streets to be mapped. Exhibit the neighborhood leaves next to the tree location.


LEAF VEINING
Pinnate
Palmate
Parallel


TWIG ARRANGEMENT
Alternate
Opposite
Whorled

CONCEPT - Trees can manufacture their own food.

1. Discuss that most plants make their food and animals cannot.

2. Select several animals and trace their existence or dependence upon plants. Discuss the importance of oxygen.

3. Develop defintion for photosynthesis. Define the words photo and synthesis.

4. Read about growing plants from seeds and discuss why the seeds do not require nutrients from the soil. Question: Why do mature trees require supplementary materials from the soil?

5. Show that green leaves, containing chlorophyll, respond to changes in light. Use a plant which is growing well and carefully place a black envelope on one leaf in such a way that light may not enter, but ventilation is not stopped. Keep the leaf covered in this manner for about a week and then remove the envelope. Questions: How has the leaf changed? Does the leaf have as much chlorophyll as the others?

6. Conduct a simple demonstration that plants need sunlight, air and water. Place four seedlings in small flower pots. Place one plant in a jar and seal it tightly. To provide water for the plant, set the plant on top of an inch or more of wet moss, cotton, or toweling. Do not place this plant in the direct sunlight. Place one plant in an open jar in complete darkness, and water as needed. Place one plant in an open jar in sunlight, and water as needed.

7. Grow two bean plants in separate pots. After they have grown to a height of two or more inches, place these plants in a dark place such as a closet. The leaves of these plants will eventually lose most of their green coloring. After a week or so, remove one plant and place it where it will receive sunlight. Gradually, the leaves of this plant will turn green again. In time the leaves will be as green as they were before they were placed in the closet. Questions: What happens to the plant that has been left in the dark closet? What is the color of its leaves? How does light affect the growth of plants.

CONCEPT - Trees change with the seasons as an adaptation for survival.

1. Problem

How do trees change from one season to another?

Materials

Tree (on the school grounds or nearby).

Procedure

Select a tree on or near the school grounds to observe during the entire school year. Develop the kind of records they might keep. A pictorial record of the tree might be kept for the children's study. In addition to the sketches of the tree's general appearance, the children might want to prepare a pictorial record of the development of the buds and leaves, among other visual observations. Written records can be maintained of air temperature (measured approximately 6 feet above the ground level and other levels if the temperature can be safely measured), dates of leaf emergence and appearance, condition of buds (sticky, scale, protection), appearance of bark, leaf coloration during various seasons, and other items selected by the children for their inquiry.

In addition, the children might want to study an evergreen tree and compare these observations in detail with the observations made of deciduous tree. Have the children make individual observations of trees in their neighborhood and bring these in for comparison with other observations in the group.

Results/Conclusion

Trees adjust to seasonal changes in various ways.

CONCEPT - Man is dependent upon plants for most of his requirements and luxuries.

1. List and discuss objects made from plants at school and at home.

2. Collect plant fibers, such as cattails (used by Indians). Make simple mats and baskets. If raffia is used let the children know that it comes from raffia palm.

3. Discuss the contributions of the kinds of plants beneficial to man. Questions: Are there harmful plants? List some of them.

4. Make a scrapbook showing foods and products obtained from trees. Use pictures and/or children's illustrations. Divide the project into the following categories: stems, leaves, seeds, roots, and fruits.

5. Prepare a tackboard using pictures and illustrations depicting the following:

   trees which provide food
   trees which provide clothing
   trees which provide other useful products

6. List and discuss the many ways in which trees benefit us. Question: Do trees aid both plants and animals? How?

7. Construct a diorama of a room featuring furniture produced from trees. Trace the origin of the materials and discuss the reasons for their use. Question: Why is redwood used so frequently as an exterior surface?

8. Look about the classroom to locate items derived from plants. (Paper, string, cork, rubber, linen) List the items on the chalkboard and in the children's notebooks.

9. Bring in specimens or pictures of plants and materials derived from them for a bulletin board display.

10. Bring to the classroom an article of food which came from a plant with a picture of the plant from which it came. Put this collection on display on the exhibit table. Make a report on the food which has been brought to class, where it grows best, how it grows and how it is processed, if it is.

11. Collect pictures of beverages. Under each picture, tell from what plant the beverage originated and from where the plant comes (geographically).

12. Put samples of materials which come from plants in the class scrapbook and write a short description of the plant and where it grows.

13. Make a report of how plants are used to shelter man in a particular country.

14. Report on the value of plants in medicine.

15. Conduct research in regard to the kind of trees used in the making of various types of paper.

16. Discuss the fuels used by man that originate from plants.

17. Discuss the products that man uses today that are manufactured from plant products.

18. Explain what is meant by "chemurgy" (the science of finding industrial uses for the raw materials of farm and forest).

<u>CONCEPT</u> - In seed bearing plants pollen must be transferred from the stamen to the pistil to start seed development.

1. Obtain some mature tulip, iris, or pansy blossoms. Identify the parts. Draw a picture of them in a notebook and label them.

2. Draw and label the cross section of a typical flower.

3. Bring in some dandelions, daisies, clover, cottonwood catkins, or snapdragons. Distinguish between simple flowers and compound flowers.

4. Discuss and/or make reports on the following:

   self-pollination
   cross-pollination
   artificial pollination

5. Explain how each of the following affects the pollination process:

   insects
   birds
   the wind

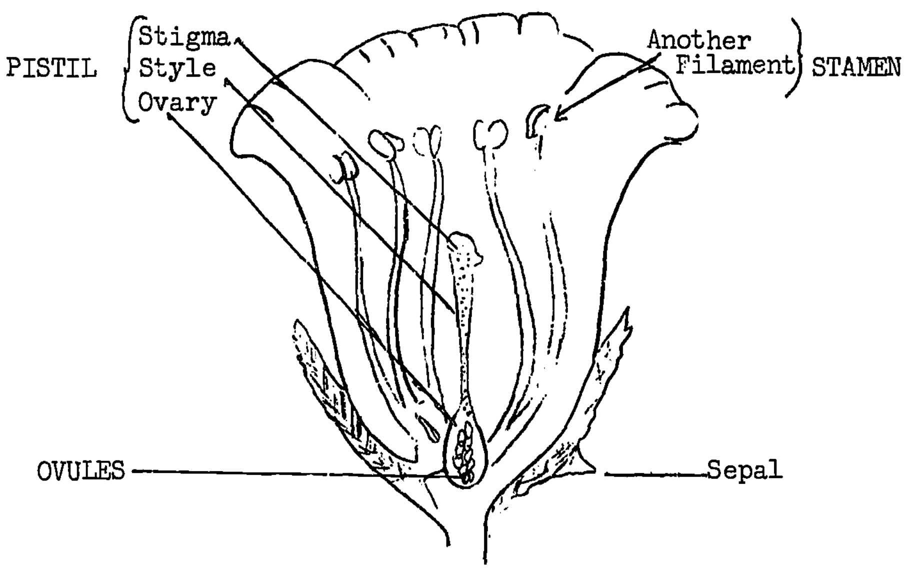
6. Locate the pistil in several kinds of flowers. Note the enlarged top of the pistil or the stigma. Questions: What are the characteristics? Rough? Smooth? When is it sticky? Why?

7. Cut open the pistil of some simple flower. Examine the interior with magnifying glass. Describe.

8. Obtain several flowers in which the pollen has formed on the stamens. Shake the pollen from each flower on different pieces of dark paper. Observe each type of pollen with a magnifying glass or microscope and note differences. Question: Are there advantages in some types?

9. Germinate pollen grains: Make a strong sugar solution and place it in a shallow dish. Shake pollen from several flowers onto the sugar solution. Cover the dish with a piece of glass and let it stand in a warm place for several hours. If the demonstration is a success, little tubes will be seen growing from the pollen grains. Use a microscope.

CROSS SECTION OF A TYPICAL FLOWER



CONCEPT - Plants can be improved through selection and hybridization.

1. Discuss how plants can be improved through selection.

2. Collect pictures or make illustrations of plants that have been changed by human beings. Display them.

3. Report on "Luther Burbank" the plant magician.

4. Discuss examples of Burbank's work.

5. Show that plants can be improved through selection and hybridization Obtain several seed catalogues which note kinds and numbers of various fruits, vegetables, flowers. Many catalogues will highlight their most recent developments in selection and hybridization.

6. Demonstrate the processes of grafting and/or budding.

CONCEPT - Plants cannot grow properly without certain nutritional elements that are usually obtained from the soil.

1. Problem

   Can plants be grown without soil?

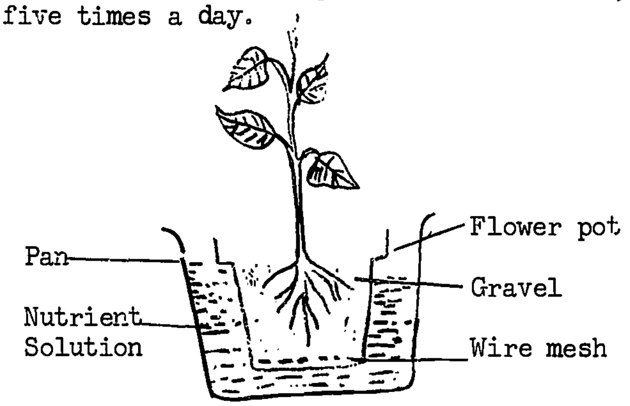
   Materials

   2 large flower pots, 2 deep pans (almost as deep as the pots), gravel (enough to fill the pots), 2 square wire mesh screens (large enough to cover the opening at bottom of pot), 4 seedlings of fast-growing plants (oats, wheat, radish, or mustard), 2 one-gallon jugs, commercial liquid fertilizer, distilled water (from a drug store).

Procedure

Place a wire mesh screen at the bottom of each pot, and fill the pots with gravel. (This is to give support to the plants.) Carefully plant two seedlings in each pot, without damaging the roots, and then prepare two watering solutions. Into one jug pour the liquid fertilizer, diluted according to the directions on the label. (You may have a student read aloud the label of the fertilizer to see what the necessary nutritional elements are.) Into the second jug pour distilled water. (Rainwater that has been collected in a clean glass or plastic bowl may also be used.)

Place each flower pot in a deep pan, and water one pot with distilled water and the other with the liquid fertilizer. Let the liquid rise nearly to the rim of the dish. Let the pots stand for about 15 minutes. Then take them out, letting whatever liquid they still hold run into the dish below. Place the pots in a well-lighted part of the room. The watering solutions in the pans can then be poured back into the jugs for use later. (You will probably have to make a new solution of fertilizer once or twice a week.) Repeat the watering of the plants about three times a day. If the plants start to wilt, increase the watering to five times a day.



In about a week or ten days, the plants should show some changes. The class should then make a chart to record weekly progress. Ask them if they see any differences in the color of the two sets of plants. Is one set taller than the other? Does one set have more leaves than the other? Is one set beginning to wilt? Does it have any area of discoloration? (The plants watered with the fertilizer solution should be healthier in all respects.) Ask the children if they know why these changes occured. (One set has the necessary nutritional elements and the other did not.) The children can record their observations in a chart similar to the following.

Week	Plant watered with distilled water		Plant watered with fertilizer solution		
	Height	Number of leaves	Color	Number of leaves	Color
1					
2					
3					
4					

Results/Conclusions

Plants cannot grow without certain nutritional elements. Normally, plants obtain these elements from the soil, but they may obtain the elements directly from the chemically prepared water instead. Soil is not necessary to raise plants.

CONCEPT - A growing plant is influenced by many factors in its environment, including gravity. As the plant grows, it changes position in response to gravity. This movement is called geotropism. The effect of geotropism is greatest on those areas of the plant where growth occurs, the budding stems and the tips of roots.

1. Problem

How does gravity influence the directions in which roots and stems grow?

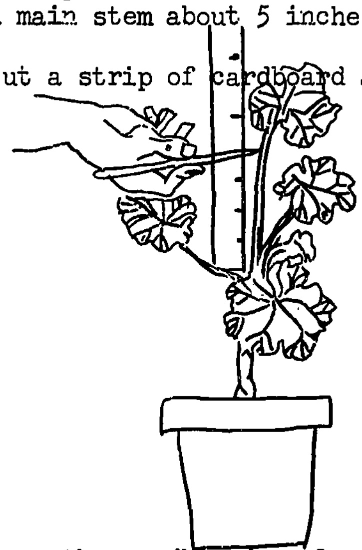
Materials

Two potted plants (bean, sunflower, or geranium), india ink, marking pen or felt pen, ruler, cardboard strip.

Procedure

The two potted plants used in this activity should be the same kind so that variations among species will not confuse your results. Each plant should have a main stem about 5 inches tall bearing several leaves.

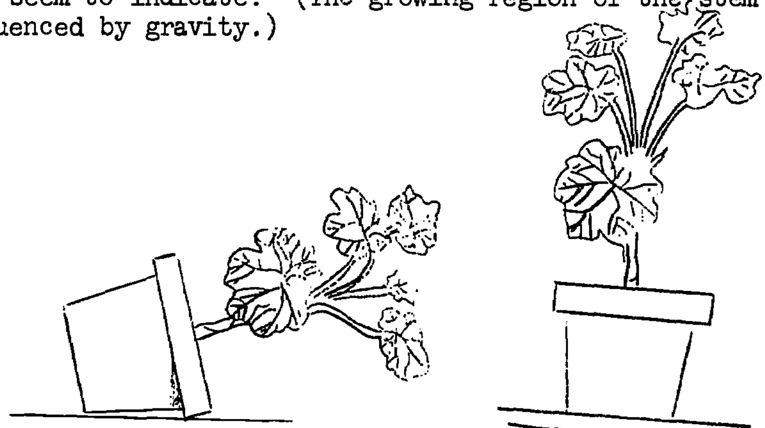
Have the children cut a strip of cardboard about 6 inches long and mark every $\frac{1}{2}$ inch.



They should then place the cardboard scale against the main stem of each plant and make a mark on the stem every $\frac{1}{2}$ inch. Have them start at the top of the stem and mark down along it for at least 3 inches. Marking may be done with a brush and India ink, or a marking pen.

Have the children place one of the plants in a horizontal position and the other, the control, in a vertical position. The children should be led to suggest that both be placed in a dark room to insure that gravity, not light, causes any changes in position.

Just before the light is turned off, have the children observe the position of the stems in both plants. One effective way to record their observations is to have them sketch each plant. In about three days, have the children return to the dark room. They should observe and record by drawing that the stem of the horizontally placed plant now curves upward. The children should also compare the markings on the stem of both plants with those on the cardboard scale. From their observations, the children can consider the following questions: How does the control plant (vertical) compare with the experimental plant (horizontal)? Where did the greater amount of growth occur? (Near the tip of the stem.) Where did the curvature in the experimental plant occur, if any occured? (Near the tip of the stem.) What does this seem to indicate? (The growing region of the stem is most influenced by gravity.)



After the children have observed the effects of gravity on the stems, have them remove each plant from its clay pot, soak the packed soil in water, and carefully break the soil away. Caution the children not to break the main, or primary, root of the plant. Have the children examine each primary root to note if there has been any gravitational effect on its growth. (The root of the horizontally placed plant will have turned downward toward the gravitational pull of the Earth. The root of the vertical plant was already growing in the direction of the gravitational pull of the Earth.)

Now have the children compare the direction in which the root of the horizontal plant grew with that in which the stem grew. What do they conclude? (Roots are positively geotropic; they grow toward the gravitational pull of the Earth. Stems are negatively geotropic; they grow away from the gravitational pull of the Earth.)

Results/Conclusions

Plants respond to the gravitational pull of the Earth. Roots are positively geotropic; stems are negatively geotropic.

Evaluation

Included here are samples of evaluation items which could be used in developing your own informal testing program. These suggested types of items cover the particular science area that has been developed in this section of the handbook. This also means they could be used to help develop informal testing to cover large areas of information (monthly, mid-year, end-of-year testing). These are by no means complete tests as such. You will have to adapt and develop items to meet <u>your</u> particular class's own individual needs and differences.

<u>Think of a word that correctly completes each sentence and write it in the blank space.</u>

1. Trees make food in their ____(leaves)____.
2. The covering that protects the inside of a tree is called __(bark)__.
3. Trees cannot make food from water and carbon dioxide unless they also have ____(sunlight)____.
4. All animals depend on __(plants)__ for food.
5. Most plants grow from __(seeds)____.

<u>From the list pick the words that are needed to complete the story and write them in the correct places.</u>

cork	palm	cascara
mahogany	evergreen	bulb
maple	lilac	

Trees are divided into hardwood and softwood families. An example of a hardwood tree is the __(mahogany)____ tree. A softwood tree is the ___(palm)___ tree. We make syrup from the sap of one kind of tree; that is the _(maple)_ tree. A tree that keeps its leaves all year long is called an ____(evergreen)___ tree. A _(bulb)___ is an onion-like part that has stored food.

<u>Name a plant that is able to make new plants by the method listed.</u>

1.	From stems on top of the ground	strawberry
2.	From an underground stem	iris, cattail, white potato
3.	From the leaves	walking fern
4.	From roots	grasses, sweet potato
5.	From bulbs	onion, narcissus, daffodil

Underline the correct answer in each of the following sentences:

1. When material from the pollen grain joins the ovule, the ovule becomes a(n) a. fruit b. <u>seed</u> c. ovary d. pistil.

2. The part of a flower that has a tiny knob at its tip and contains pollen is the a. petal b. pistil c. <u>stamen</u> d. ovule.

3. Insects and birds may be attracted to flowers by a. minerals b. <u>nectar</u> c. size of flowers d. number of flowers.

4. The colored portion of a flower that also helps to attract birds and insects consists of the a. ovules b. stamens c. <u>petals</u> d. pistils.

5. The part of the flower in which the ovules are formed is called the a. stamen b. <u>ovary</u> c. stigma d. fruit

Write the number of the word group in column A in the space before the item in column B that it best matches.

Column A	Column B
1. Contain a young plant	2 a. Petals
2. Surround the seed-making parts of a flower	5 b. Lima bean
3. Part of the pistil that will become a seed	4 c. Pollen
4. Carried to the pistil	___ d. Filament
5. Has two seed halves	1 e. Seeds
	___ f. Corn seed
	3 g. Ovule

A list of terms is given below. Select the term from the list that goes with each statement. Write the term in the space before the statement.

1. (Ovary) -enlarged part of the pistil
2. (Seed) -contains stored food
3. (Pistil) -shaped like a long-necked vase
4. (Fruit) -a ripened ovary
5. (Stamen) -flower part that makes pollen

Complete the following sentences:

1. Plants or parts of plants that insects eat are (fruits, leaves, corn, etc.).
2. Other things besides insects that can destroy plants are (fire, drought, flood, etc.).
3. In plants, water rises from the roots to the leaves through the (stem).
4. In order to grow, seeds need (air, water, warmth, soil (any one or more of these)).
5. A plant that has a seed with one part is (corn).

Complete the following sentences:

1. A green substance found in most plants is called (chlorophyll).
2. A ripened ovary with its seeds is called a (fruit).
3. Monocot leaves have veins that are (parallel).
4. Plants that have their petals and stamens in groups of 4 or 5 are called (dicots).
5. A spruce tree is an example of a (conifer).

Write a brief but complete answer to each of the following:

1. In their proper order, tell what things must happen before a flower can make seeds.

   a. (Pollen from the stamen must reach the stigma of the pistil.)

   b. (From the pollen grain a tube must grow down the pistil into the ovary, where it joins an ovule.)

   c. (Material from the pollen grain must flow down the tube into the ovule.)

2. What are two types of seeds? Name a plant that produces each of these types of seeds.

   (The two seed types are (a) the monocots, which have one food part, and (b) the dicots, which have two food parts. Corn produces monocot seeds, beans produce dicot seeds.)

Write the number of each word group in column A in the space before the item in Column B that it best matches.

Column A	Column B
1. One-celled fungi	__4__ a. Monocots
2. Tube bundles of the stem arranged in rings	__1__ b. Bacteria
3. Ancestors of the ferns	__2__ c. Dicots
4. Tube bundles of the stem scattered haphazardly	____ d. Spores
5. Begin a food cabin	__5__ e. Algae
	____ f. Conifers
	__3__ g. Mosses

Underline the correct answer in each of the following sentences:

1. Yeast cells give off a gas called a. oxygen b. hydrogen c. nitrogen d. carbon dioxide.

2. Mold plants produce new mold plants by means of a. eggs b. seeds c. spores d. ovules

3. The ancestors of present-day conifers are thought to have been a. algae b. mosses c. bacteria d. ferns

4. A combination of an alga and a fungus is called a a. lichen b. spore c. dicot d. monocot.

5. Euglena moves by means of a. tentacles b. flagella c. legs d. whip arms.

6. Plants that make seeds in cones are called a. monocots b. dicots c. algae d. conifers.

7. Fern plants grow from a. spores b. seeds c. eggs d. root parts.

8. Simple plants having chlorophyll are called a. spermatophytes b. fungi c. algae d. bacteria

9. An example of a monocot seed is the a. apple seed b. bean seed c. corn seed d. orange seed

10. One-celled plants that have no chlorophyll are a. bacteria b. mushrooms c. lettuce d. mosses.

A. Fill each blank with a word taken from the following list. (You will need to use some words more than once.)

chlorophyll	veins	carbon dioxide
root hairs	stomates	photosynthesis

1. Plants make sugar out of soil water and the carbon from (carbon dioxide) .
2. No plant can make food unless it has (chlorophyll) in it.
3. Air enters a plant's leaf through the (stomates) .
4. (Chlorophyll) is the green material in leaves.
5. Soil water enters a plant through tiny (root hairs) .
6. Waste oxygen leaves the plant through the (stomates) .
7. The chemical change that takes place when plants make sugar is called (photosynthesis) .
8. Simple sugars are made in plant cells by (photosynthesis) .
9. (Veins) carry soil water to the leaves.
10. Without sunlight there would be no (chlorophyll) in plants.

B. Place a T in front of each true statement. Place an F in front of each false statement.

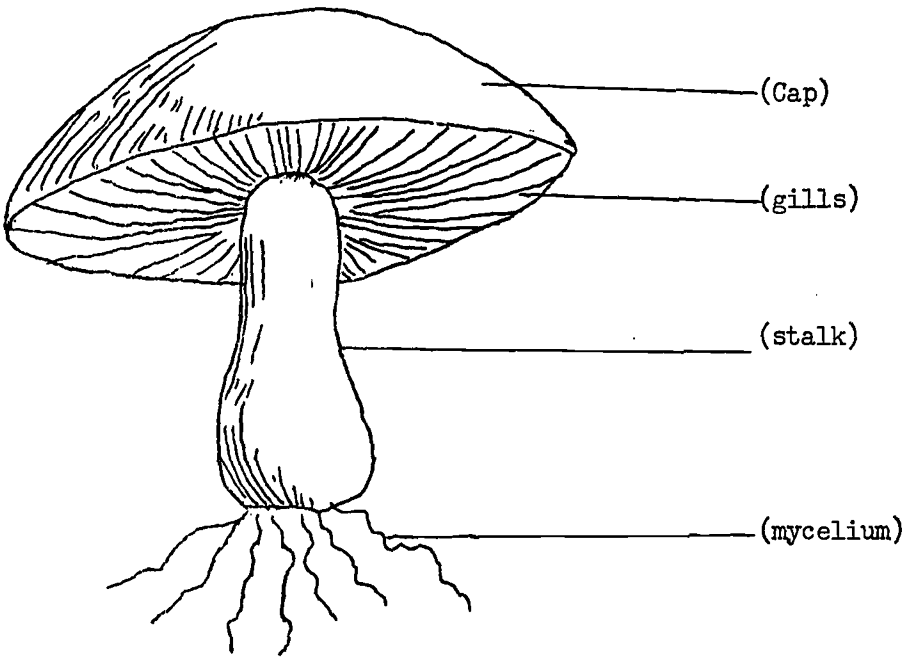
(T) 1. Green plants grow almost everywhere on the surface of the earth.
(F) 2. Green plants need the same amount of minerals, water, light air, and heat in order to live and grow.
(T) 3. Green plants cannot live where there is no light.
(T) 4. Green plants are the only things that can make their own food.
(T) 5. Green plants store their food in the form of sugar or starch.
(F) 6. Green plants make most of their food at night.

A. On the blank after each plant listed below, tell whether the plant is a dependent plant or a green plant.

1. rose bush (Green Plant)
2. yeast (Dependent Plant)
3. oak tree (Green Plant)
4. toadstool (Dependent Plant)
5. sweet potato (Green Plant)
6. moss (Green Plant)
7. grass (Green Plant)
8. sea weed (Green Plant)
9. mold (Dependent Plant)
10. pine tree (Green Plant)
11. mushroom (Dependent Plant)
12. water lily (Green Plant)
13. fern (Green Plant)
14. bacterium (Dependent Plant)
15. cactus (Green Plant)
16. fungi (Dependent Plant)

B. Label the parts of the mushroom. You will need to use these words:

stalk mycelium gills cap



C. Place a T in front of each true statement. Place an F in front of each false statement.

(F) 1. The mycelium of a mushroom is covered with spores.

(T) 2. Fungi are any or all of the dependent plants.

(T) 3. Mushrooms do not have roots.

(F) 4. Mushrooms feed on other living plants.

(F) 5. Mushrooms grow best in dry places.

(T) 6. Plants that are not green cannot make food for themselves.

(T) 7. Mold spores travel about in the air.

(T) 8. Some mushrooms are poisonous.

(F) 9. Most molds have no mycelium.

(T) 10. All fungi are dependent plant foods.

(F) 11. Molds live only on plant food.

(F) 12. Molds grow best in sunny places

(F) 13. All molds are harmful.

(T) 14. Yeasts help us make bread.

(F) 15. Bacteria give off alcohol and carbon dioxide as they grow.

(T) 16. Bacteria may be helpful or harmful.

(F) 17. Mushrooms are the smallest plants about which we know.

(T) 18. Dependent plants have no chlorophyll.

A. Here are some suggestions for planting and caring for a garden. Mark out the ones that are wrong.

1. Draw a scaled diagram of plant arrangement long before planting time arrives.

2. Improve poor soil before doing any planting.

3. (Pack the soil down firmly before beginning any planting.)

4. Read the directions on the seed packages before planting any of the seeds.

5. (Plant low growing plants to the rear of the garden.)

6. Keep the garden weeded and watered.

7. (Allow the plants to protect themselves against insect pests as best they can.)

B. Fill each blank with a word taken from the following list. (You will not need to use all the words in the list.

minerals	spading	small	sand	fertilizing
compost	clay	molds	large	transplant
mildew	weed	scale	water	poisonous

1. Any plant growing where it is not wanted is a ____(weed)______.

2. Plant parasites such and __(mildew)______ and ____(mold)____ can harm garden plants.

3. __(Transplant)_____ means to plant again in another place.

4. Insect powders and sprays are __(poisonous)____ and should be used with care.

5. __(Large)__________ seeds are usually covered with a deeper layer of soil than ______(small)______ seeds.

6. __(Compost)__________ is a mixture of things, such as leaves, which is used for fertilizing the soil.

7. __(Fertilizing)_____ the soil makes it richer.

8. Soil with too much ___(sand)_______ in it will not hold water.

9. __(Clay)__________ soil has few minerals in it and packs tightly.

Vocabulary

One of the strongest keystones of sceintific efficiency lies in its vocabulary. The scientist says things precisely, accurately, and briefly. Probably one of the greatest quarrels the science teacher may have with the elementary level teaching today is vocabulary. The science teacher can have no use for vocabulary that is not precise and accurate. Precision in vocabulary is necessary for understanding and meaning of the concept or process being learned.

The words listed below are the basic vocabulary for the indicated area of study. After each word has been introduced, its meaning is to be maintained and extended at each succeeding level of study.

flowers
leaves
plant
roots
seed
soil
stems
water
weeds
chlorophyll
fruit
green plants
products
sprout
vegetables
annual
bark
bud
autumn
characteristics
conifer
deciduous
dormant
erosion
evaporation
evergreen
fall
fossil
hardwoods
manufacture
needles
oxygen
perennial
photosynthesis
reproduction
sap
seedling
softwoods
texture
tropical
trunk
twig
cell
carbon dioxide
diffuse
fertilization
filament
germination
ovary
ovule
oxygen
petal
pistil
pollen
pollination
respiration
sepal
stamen
stigma
style
starch
algae
angiosperm
annual ring
bacteria
bark
botanist
bryophyte
bud
classification
conservation
cutting
dicotyledon (dicot)
fern
function
fungi
gymnosperm
habitat
lichens
liverwort
mold
monocotyledon (monocot)
moss
parasite
phylum
physiological
pigment
plant kingdom
ray
rhizoid
shoot
spermatophyte
spore
sporangia
structure
symbiosis
thallophyte
vascular
vegetative reproduction
teridophyte
vein
yeast

Children's Books

Books are a very essential part of the instructional materials in elementary schools which provide superior learning experiences for children. The selection of these books poses a difficult problem for librarians, teachers, and administrators because the science field is broad and increasing in scope and elementary schools science programs are varied in nature. Some of the more common specific difficulties in choosing books are: (1) finding materials which deal with the varied interests of children; (2) locating material which gives information correlated with the local school district's instructional guides: (3) finding books of appropriate reading difficulty; and (4) selecting the best books from the many available.

The following list gives help related to the first three difficulties presented. Indirectly, it also helps with the fourth difficulty, for the best books cannot be selected until they are located. Further, the brief annotations should be of help in determining which books may be best for a given class. Finally, time should be saved in the selection of the best list if some information about the reading difficulty of available books is provided. It is hoped that this list will suggest for elementary teachers books that are supplementary to basic text series, and that these books will have value either as sources of information or for recreational reading.

It is always hazardous to specify an exact grade placement for a book because of variations in pupil reading ability in any class group, and because of different uses made of books. Consequently, the lowest grade level for pupil use is indicated. At lower levels these same books may be useful if the teacher reads to the children.

This list has been adapted from the publication of Children's Catalog (1966).

Bancroft, Henrietta Down Come The Leaves; illus. by Nonny Hogrogian. Crowell 1961 unp illus (Let's-Read-And-Find-Out-Bks) $2.95 (k-2) In the autumn leaves fall because their work---the vital task of food-making---is done. This elementary science book tells about the work of these leaves and the various kinds that fall from different trees.

Blough, Glenn O. Wait For The Sunshine; The Story Of Seasons And Growing Things; pictures by Jeanne Bendick. McGraw 1954 47p illus (Whittlesey House Publications) $3.25 (2-4) In this simple introduction to botany, Pete learns about the sun's part in helping things grow; through the seasons he watches plants, learning about their structure, how they work together and how they supply much of the food that we eat. "For the youngest elementary school children, this is an accurate picture of plant growth... Well illustrated."

Caulfield, Peggy Leaves; photograph by the author. Coward-McGann 1962 72p illus $2.75 (4-6) A "detailed study of leaves which shows how they grow in the spring, mature and make food in the summer, and die in the fall. Topics such as transpiration, leaf coloration, and tree dormancy are explained simply and understandably. Suggestions for leaf collecting are given."

Cooper, Elizabeth K Insects and Plants; The Amazing Partnership; illus. by Shirley Briggs. Harcourt 1963 153p illus $3 (5-7) "An excellent book on the subject of plant and insect partnerships... carefully illustrated, and useful for the beginning biology student or for the amateur interested in nature study. Miss Cooper describes the morphology and physiology of flowering plants and of those insects that are involved in some part of the botanical cycle. The details of insect pollination, of devices of floral attraction, of host relationship, and of carnivorous plants are discussed, the text also give suggestions for observing and experimentation. An index and a list of sources for obtaining live specimens are appended."

Dickinson, Alice The First Book Of Plants; pictures by Paul Wenck. Watts, F. 1953 93p illus $1.95 (4-6) For beginners this is "a lucid and informative introduction to the study of plants---kinds, structure, how and where they grow, how they manufacture food, how they propagate, their use and importance to other living things. In addition to the clear drawings on every page there are several pages of captioned pictures which supplement the text. A few experiments are included."

Fenton, Carroll Lane Plants That Feed Us; The Story Of Grains and Vegetables, by Carroll Lane Fenton. Day 1956 95p illus maps $3.50 "In this popular treatment the authors cover grains and vegetables from artichokes to zucchini, treating with the history of these plants, their origin and introduction to other parts of the world, and the achievements of man in improving upon nature through cross-breeding."

Foster, Willené K. Seeds Are Wonderful, by Willene K. Foster and Pearl Queree; illus. by Arnold Dobrin. Melmont Pubs. 1960 31p illus (Look, Read, Learn) $2.50 (1-3) "Explains to the beginner that each type of plant has his own unique seed. The ways in which plants protect their seeds are pictured, and the growth, flowering, and production of seeds is described. Several easy experiments are suggested."

Guilcher, J. M. A Fruit Is Born by J. M. Guilcher and R. H. Noailles. Sterling 1960 111p illus (Sterling Nature Ser) $2.95 (4-7) "Brief text and 137 remarkable cross-sectional and magnified photographs reveal the life cycle of fruit. The book begins by explaining, with diagrams, the structure of a pistil and then shows the development of fruit from flower to seed, using examples of different types of fruit. A final chapter classifies edible fruits and discusses seed dispersal."

Hutchins, Ross E. Strange Plants And Their Ways; with 60 photographs by the author. Rand McNally 1958 96p illus $3.50 "After first explaining how ordinary plants live, grow, and reproduce (the author) decribes in animated text and excellent photographs the strange habits of such plants as the yucca tree, Venus flytrap, pitcher plant, mistletoe, lichen, mangrove tree, slime mold, and jumping bean, and offers some helpful suggestions for making a hobby of plant study."

Jordan, Helene J. How A Seed Grows; illus by Joseph Low. Crowell 1960 unp illus (Let's-Read-And-Find-Out Bk) boards $2.95 (1-2) "Begins by explaining that the seeds of different plants are different and grow differently. Then suggests that the student plant and care for some bean seeds in order to observe how they develop; thus it effectively teaches the beginner how a seed grows into a plant."

-----Seeds By Wind and Water; illus. by Nils Hogner. Crowell 1962 unp illus (Let's-Read-And-Find-Out Bks) boards $2.95 (k-3) "Wind and water, dog and cats, birds and squirrels, even the tires of airplanes and automobiles carry seeds...(The author explains) how various seeds have become adapted to movement...and transported from place to place. Some seeds actually move by themselves, propelled by mechanisms in the plant."

Lubell, Winifred Green Is For Growing, by Winifred and Cecil Lubell. Rand McNally 1964 64p illus $2.95 (2-4) This "nature picture book, written in rhythmic prose, tells in simple language the facts about many growing plants, starting with algae. It goes on to fungi, lichen, moss, ferns, and flowering plants, explaining the difference between plants which are reproduced by seed and those that grow from spores."

Neurath, Marie How Plants Grow. Sterling 1961 36p illus (Full Color Nature Ser) $2.50 (3-5) "Simple text and pictures in color show how a variety of plants and flowers grow, how insects and birds help them to propagate, and how life goes on in the plant world."

Poole, Lynn Insect-Eating Plants by Lynn and Gray Poole; illus. by Christine Sapieha. Crowell 1963 87p illus $3.75 (3-6) "The authors have selected Venus' flytraps, the sundews, pitcher plants, bladerworts, and some fungi. In each class there is a detailed description of the plant, its habit of growth, its geographical location, and manner of trapping and digesting insects. The author's fascination with the complex behavior or these relatively simple organisms is infectious. There are excellent directions...for planting, caring for, and observing these plant traps in action in a terranium.... The clear black-and-white line drawings complement the text."

Selsam, Millicent E. Birth Of A Forest; illus. with pictures by Barbara Wolff and with photographs. Harper 1964 unp illus boards $2.50 (4-6) The author reveals the process by which "a forest is born over a period of thousands of years: Soil washes into a lake, plants and animals die in the lake, and gradually it changes to dry land on which prairie grasses and tall forest trees can grow. There is a great deal of information to observe and explore outdoors. Dramatic photographs accompany charming detailed drawings."

-----Plants That Heal; illus. by Kathleen Elgin. Morrow 1959 96p illus $2.94 (5-7) "The plant kingdom was man's only drugstore for countless centuries. Thus opens a brief and fascinating history of man's use of roots, stems, leaves, and seeds of plants to heal (and some to poison, too). A resumé of superstitions and magic, prescriptions in medieval herbals and Indian folk medicine (now being studied anew) precedes description of recent discoveries of antibiotics and vitamins. Clear botanical sketches; a list of common and sceintific plant names, and an index."

-----Plants That Move; illus. by Fred F. Scherer. Morrow 1962 127p illus $2.95 (3-6) "The first section of this book describes the movements of leaves and flowers and the second describes those of vines.... Accurate drawings show exactly what happens when a plant moves."

-----The Plants We Eat; illus. by Helen Ludwig. Morrow 1955 123p illus $2.95 "Discussion of the dependence of human life on plants precedes chapters giving the history and use of various kinds of plant foods, classified as roots, stems, leaves, flowers and fruits. Strange and little-known facts about the wild and cultivated forms of (various) plants .... make interesting reading. The book is well designed, with many sketches showing root development, seed arrangement, and cross-sections of other plant parts. Easy to read and inviting with suggestions for simple experiments."

-----Play With Plants; pictures by James MacDonald. Morrow 1949 62p illus $2.94 (3-7) "This book of plant experiments, presented in simple, detailed explanations...has both informational and entertainment value. There are experiments with plants which grow from roots, stems, leaves, and seeds, and others showing how seeds grow, how plants use water and respond to light. There is also a brief chapter on conducting experiments. Materials needed are readily available in the home and all experiments can be performed without an outdoor garden."

-----Play With Seeds; illus. by Helen Ludwig. Morrow 1957 93p illus $2.94 (4-6) "Excellent informative introduction to the study of plants and seeds .... Traces their evolution on earth from their beginnings 100 million years ago. Clear explanations, accompanied by detailed black-and-white drawings show the development of the seed in a wide variety of plants. The travel of seeds, both useful and harmful aided by birds, wind, and man is described with interesting details. Numerous simple but enlightening experiments are suggested. Index adds to the usefulness."

-----Seeds And More Seeds; pictures by Tomi Ungerer. Harper 1959. 60p ilus (And I Can Read Science Bk) $1.95 (K-2) "Enjoyable pictures and story tell how a little boy named Benny learns by experimentation and observation what seeds are, how they grow, where they come from, and how they are dispersed. This easy science book will find a place on the primary shelves of public and school libraries. Simple vocabulary, much repetition, and large print, but good story, simple science information, and colorful illustrations."

Steffeurd, Alfred The Wonders of Seeds; illus. by Shirley Briggs. Harcourt 1956 119p illus $2.75 "Discussion of many kinds of seeds---how they are formed, sprout and spread. Included also are a few experiments for children to try, and something about the work of Mendel and other scientists in the field.... (There are also) unusual facts and true tales."

Swain, Su Zan Noguchi Plants of Woodland And Wayside; written and illus. by Su Zan Noguchi Swain. Garden City Bks. 1958 57p illus $2.75 "Discussion of many kinds of seeds---how they are formed, sprout and spread. Included also are a few experiments for children to try and something about the work of Mendel and other scientists in the field... (There are also) unusual facts and true tales."

Webber, Irma E. Bits That Grow Big; Where Plants Come From. Scott, W.R. 1949 64p illus (Young Scott Science Bks) boards $2.75 (2-4) "A most excellent book about plant reproduction developed by means of experiments that children can make. Where plants come from,---seeds, spores, cuttings, graftings, leaves and roots,---all are discussed in simple and pleasing text.

-----Travelers All; The Story Of How Plants Go Places, written & drawn by Irma E. Webber. Scott, W.R. 1944 unp illus $2.50 (2-4) "Illustrates some of the many methods of seed dispersal, showing how they float in the air and on water, move on the ground and are carried by animals."

-----Up Above And Down Below. Scott, W.R. 1943 unp illus $2.50 (1-3) "A few lines of easy text, accompanied by simple full-page illustrations, show the parts of a plant above and below ground, giving some idea of various kinds of stem and root. This little book written by a botanist as introduction to nature study for very small children should prove useful."

Zim, Herbert S. What's Inside Of Plants? Illus. by Herschel Wartik. Morrow 1953 32p illus $2.75 (2-4) "A general discussion of plants and their roots, stems, leaves, flowers and fruits. The pages are alternately in large and small type, the former intended for beginners and the latter offering slightly more advanced information."

Allen, Gertrude E. Everyday Wildflowers. Houghton 1965 47p illus $2.75 (K-2) "An introduction to seven common wildflowers for pre-school children that will teach a few basic elements of plant anatomy and reproduction. Featured are the violet, skunk cabbage, Queen Anne's lace, milkweed, water lily, blue flag and Indian pipe."

Buff, Mary Big Tree, by Mary & Conrad Buff. Viking 1946 79p illus $3.50 (5-7) "The author-illustrators of this beautifully designed book communicate to the reader a sense of wonder at the grandeur and antiquity of the sequoias and a deep need to preserve them against their enemies for all time. The story of a special sequoia, Wawaona, symbolizes the growth of these magnificient trees. A distinguished book for (those)... who are sensitive to the beauties of nature."

Bulla, Clyde Robert A Tree Is A Plant; illus. by Lois Lignell. Crowell 1960 unp illus (Let's Read And Find Out Bk) boards $2.95 (K-2) "The text presents very simply the fact that there are many kinds of trees, that they reproduce by seeding and that an apple tree will be chosen as an example of a tree. The cycle of growth and the seasonal changes, the structure and the functioning of the parts are then described in terms of the apple tree. Pleasantly illustrated and well organized, the greatest asset of the book is in the limitation of information: there is no extraneous information or terminology that might confuse the reader.

Cavanna, Betty The First Book Of Wild Flowers; pictures by Page Cary. Watts, F. 1961 268 p illus $1.95 (4-7) "Competently written, with good general information preceding the material on the flowers themselves. Common and scientific names are given for each flower, and the descriptive paragraphs are succinctly informative. The one weakness of the book is the fact that the illustrations (precise and accurate) are in black and white rather than in color, and are therefore less useful for the purpose of identification."

Collingwood, G.H. Knowing Your Trees, by G.G. Collingwood and Warren D. Brush Rev. and ed. by Devereux Butcher.... Am. Forestry Assn. 1963 349p illus maps $7.50 "With more than 900 illustrations showing typical trees and their leaves, bark, flowers, and fruits."

Cormack, M.B. The First Book Of Trees; pictures by Helene Carter. Watts, F. 1951 93p illus maps $1.95 (3-6) An "Accurate and interesting work... (it) is a thing of beauty as well as a source of information on the growth and habits of trees and a practical guide for identifying over fifty varieties of trees in North America... Lovely soft greens and browns (are) used in the book. For each tree are pictured the leaf, flower, fruit and bark as well as the general outline of the tree itself. A map set into the corner of the page shows in what part of the country the tree grows."

Darby, Gene What Is A Tree; pictures (by) Lucy and John Hawkinson. Benefic Press 1957 48p illus (What Is It Ser) $1.80 (2-4) "Tells how a tree grows from a seed and describes the functions of the roots, trunk, branches and leaves. Drawings of a few common American trees aid identification. Some of the products which man derives from trees are illustrated.

Dowden, Anne Ophelia T. Look At A Flower; illus. by the author. Crowell 1963 120p illus $4.50 (6-7) Starting with a chapter on the classification of plants "the author goes on to examine the structure of plants, the manner in which seeds are produced, and the techniques of pollination. Each part of the flower is described and pictured in detail. Ten of the most common plant families are described."

Downer, Mary Louise The Flower; pictures by Lucienne Bloch. Scott, W.R. 1955 unp illus $2.50 (K-2) Explanation of the life cycle of a flower from seed to blossom and back to seed again.

Dudley, Ruth H. Our American Trees; illus by Nils Hogner. Crowell 1956 147p illus $3.50 (5-7) "A well-organized, concisely written account of American forest trees: growth, kinds of trees and their characteristics, importance, uses, what the government has done and is doing to conserve them and ways in which the individual can help. Informative and readable, the book contains many odd and interesting facts not found in other books on the subject. Includes a two-page chart map of the major forest area in the U.S., addresses of state forestry agencies and a list of books for further reading.

Fenton, Carroll Lane Trees And Their World, by Carroll Lane Fenton and Dorothy Constance Pallas; illus. by Caroll Lane Fenton. Day 1957 96p illus $3.50 (4-7) This book "is an introduction to these large and important plants. It begins by telling what trees are and the families to which they belong... We find out why some trees lose their old bark every year and how trees leaves manufacture food, and how the whole tree makes use of it. We also discover the steps by which a tree grows, why roots have to breathe, and how seeds develop."

Guilcher, J.M. A Tree Is Born, by J.M. Guilcher and R.H. Noailles. Sterling 1960 100p illus (Sterling Nature Ser) $2.99 (3-6) This book "takes up the life cycle of four trees; horse chestnut, oak, walnut, and pine. Well illustrated with 127 photographs which are exceptionally well reproduced. Printed in France, it makes a welcome addition to information already available on the subject."

Hausman, Ethel Hinckley Beginner's Guide To Wild Flowers; illus. by the author Putnam 1955 376p illus $3.95 "A small, simple, but complete guide to wildflowers whose handy size and arrangement of flowers by color make it valuable for use in the field. A clear line drawing of each species is placed next to its description: descriptions give the Latin name, common names, size of plant, flowers and leaves, distinguishing characteristics, range, habitat, flowering time and family. Intended primarily for east of the Mississippi River, but contains some species occuring farther west."

Lane, Ferdinand Cole All About The Flowering World; illus. by Russell Francis Peterson. Random House 1956 141p illus (Allabout Bks) $1.95 (4-6) "An animated discussion of flowering plants--structure, pollination, seeds and seed dispersal, growth, enemies, origins, unusual plants and habitats, experimentation and culture, and the many important uses of flowering plants to mankind. An interesting general treatment."

Lemmon, Robert S. Junior Science Book Of Trees; illus. by Rene Martin. Garrard 1960 63p illus (Junior Science Bks) $1.98 (2-4) "The author takes young readers on a trip through the tree world examining the tree roots and their job of feeding the tree, the small seed and how it grows, the air and its influences on the leaves and the various species of trees and how to differentiate among them."

The Macmillan Wild Flower Book; descriptive text by Clarence J. Hylander; illus. by Edith Farrington Johnston. Macmillan (N Y) 1954 480p illus 232 plates $9.95 "Approximately 425 flowers are pictured and approximately 500 are described in the notes that accompany the plates. Arrangement of by families; an index refers to the descriptive notes which in turn refer to the plates. The descriptive notes give information on appearance, structure habitat of the plants."

Milne, Lorus J. Because Of A Tree (by) Lorus J. Milne & Margery Milne; drawings by Kenneth Gosner. Atheneum Pubs. 1963 152p illus $3.95 An ecological study "emphasizing the interdependence among trees and various insects plants and animals. Various chapters consider the apple, sugar maple, fir and spruce, palm, bald cypress, redwood, aspen, saguaro (cactus) trees."

Petrides, George A. A Field Guide To Trees and Shrubs.... Illus. by George A. Petrides (leaf and twig plates) (and) Roger Tory Peterson (Flowers fruits, silhouettes) Houghton 1958 xxix, 431p illus (Peterson Field Guide Ser) $4.50 "Field marks of all trees, shrubs, and woody vines that grow wild in the north-eastern and north-central United States and in southeastern and south-central Canada."

Rush, Hannifold The Beginning Knowledge Book Of Backyard Trees; illus. by Raul Mina Mora. Macmillan (N Y) 1964 unp illus (Beginning Knowledge Bks) boards $1.95 (1-3) An introduction to trees: kinds of common trees, their characteristics, and uses.

Selsam, Millicent The Doubleday First Guide To Wild Flowers; illus. by boards $1.50 (3-5) This book identifies 60 common wild flowers that can be found in a backyard, a meadow, or in the woods. The flowers described are grouped according to color.

-----Play With Trees; pictures by Fred F. Scherer. Morrow 1950 64p illus "A good introduction to the study of trees and how they grow showing how they can be distinguished by their shapes, bark, buds and leaves. It gives the methods for collecting and preserving leaves and twigs, and it is illustrated by numerous black and white drawings."

Webber, Irma E Thanks To Trees; The Story Of Their Use & Conservation. Scott, W.R. 1952 60p illus $2.75 (3-5) "Explains in simple text and pictures the improtance of trees to human life---the uses of 'cut-down' trees, functions of living trees, and conservation."

Zim, Herbert S. Flowers; A Guide To Familiar American Wildflowers, by Herbert S. Zim and Alexander C. Martin; illus. by Rudolf Freund. Sponsored by Wildlife Management Institute. Golden Press 1950 157p illus maps (A Golden Nature Guide) $2.99 "This is an extremely practical beginner's guide.... To facilitate identification the flowers are arranged in four groups according to color. Each flower is pictured in color with a range map.... Brief descriptive text gives characteristics, habitat, growing season and family."

-----Trees; A Guide To Familiar American Trees, by Herbert S. Zim and Alexander C. Martin; illus. by Dorothea and Sy Barlow. Sponsored by the Wildlife Management Institute. (Rev. ed) Golden Press 1956 160p illus maps (A Golden Nature Guide) $2.99 "A beginner's pocket-size guidebook, uniform with...other titles in the Golden Nature series; illustrates in color and describes...American trees, pointing up the features important in identification---form and height of tree, leaves, bark, fruit, flowers, buds---and including, in most cases, a range map. All ages."

Sterling Dorothy The Story Of Mosses, Ferns And Mushrooms; photographs by Myron Ehrenberg. Doubleday 1955 159p illus $2.75 (4-7) "The text reveals many fascinating facts about flowerless plants: how they evolved their methods of reproduction, and some of the superstitions connected with them. Myron Ehrenberg's stunning photographs appear on

Sterling, Dorothy (Continued)

almost every page lavishly illustrating the text. Index." "As her title implies, this is more a discussion of these 'living fossils' than an identification guide, although the photographs will help children recognize many of the plants included. A useful and interesting book for nature study groups, particularly at summer camps."

Kavaler, Lucy The Wonders of Algae; illus. with photographs and with drawings by Barbara Amlick and Richard Ott. Day 1961 96p illus $3.29 (5-7) "A study of algae which describes past and present uses of the fast-reproducing one-celled plants and explores their possible future uses as medicine or fuel, in industry and agriculture, and particularly, as a source of food---especially in spaceships, nuclear submarines, and in overpopulated, underdeveloped countries."

-----The Wonders of Fungi; illus, with photographs and with drawings by Richard Ott. Day 1964 128p illus boards $3.95 (5-7) "Mushrooms, yeast, and molds---these and other varieties from the fungi plant world are...explained to the young reader along with their prominent role in man's life as both killer and miracle drug."

Kohn, Bernice Our Tiny Servants; Molds and Yeasts; illus. by John Kaufmann. Prentice-Hall 1962 62p illus $3.50 (3-5) Contents: Tiny plants; Magic seeds; The sanitation squad; Molds to eat and drink; Miracle molds; Treasure hunt for miracle molds; Enemy molds; Yeast---the baker's friend; Food of the future; Experiments with molds and yeasts.

Films

These films are available from the Central Audio-Visual Department. Contact your building A-V Coordinator to arrange for the use of these films.

All films should be previewed to determine suitability for use with your particular class.

Adaptation in Plants	17 min.	Col.	Int.

Illustrates a variety of environments in which plants survive and shows adaptations developed by various plants for survival and reproduction within their own environment. The role of man as a mediator of environment is shown as he modifies living conditions of plants, and then must provide protection for them. The viewer is encouraged to search for adaptations in the plant world around him.

Adaptations of Plants And Animals	13.min.	Col.	Int.

Examples are given of how plants and animals have adapted themselves from prehistoric times to the present. The three main adaptations are for protection, for acquiring food and for adjusting to the environment. Points out that the inability of a type of plant or animal to adjust to these factors means its extinction.

Carnivorous Plants	10 min.	Col.	Int.

Shows the unusual structure and behavior of the following plants; Venus flytrap, the trumpet plant, the cobra plant, common pitcher plant and the utricularia.

Changing Forest, The	18 min.	Col.	Int.

The forest is shown as an "integrated community of living things". The changing seasons are illustrated by shots of animals, plants and flowers. Other scenes show insects laying eggs. Woven into this is a vivid picture of the battle of each living thing for survival, often-times at the expense of other living things.

How Green Plants Make Food - Photosynthesis	$13\frac{1}{2}$ min.	Col.	Int.

Through animation, microphotography, and live action, we see how green plants make food in the process of photosynthesis.

Learning About Seeds	11 min.	Col.	Pri.

Explains that there are many different kinds of seed-bearing plants and that seeds have many sizes, shapes and colors. Through time-lapse photography we see how seeds grow and what they need for growth. Several methods of seed dispersal are also clearly illustrated.

Leaves	11 min.	B&W	Int.

Explains the function of a leaf as a food factory, surveys common types of leaves and essential parts of a typical leaf and explains photosynthesis by animation.

Life Story Of A Plant (About Flowers) 7 min. Col. Pri., Int.

Following a flower through its life cycle provides a fascinating way for youngsters to observe and generalize about the life processes of one kind of living thing - the plant. Developemnt of seeds in flowers as well as the scattering of seeds are illustrated from flowers in a near-by field.

Plants Obtain Food 15 min. Col. Int.

Asks questions about food sources for plants. Uses Coleus to illustrate food making in green plants. Shows the process of photosynthesis through cinephotomicrography and animation. Notes the phenomenon of the conversion of light energy to chemical energy. Defines important terms: carnivores, parasites, and saprophytes. Points out that all animals depend upon some form of plant life for food.

Plant Through The Seasons, A: (An Apple Tree) 12 min. Col. Gds. 1-6

Animated art work combined with live photography filmed in an orchard at all times of the year, shows the yearly life cycle of an apple tree. Adaptations for growth in temperate climates are investigated; flower formations and pollination, seed and fruit formation, and dormancy. The film stresses an inductive approach by means of which the students are led to an understanding of plant growth.

Seasonal Changes In Plants 10 min. Col. Int.

This film illustrates and explains the various changes that take place in a plant through the cycle of the seasons, using typical examples of annuals, biennials and perennials.

Seasonal Changes In Trees 10 min. Col. Pri.,Int.

Compressed into a few minutes of film time and brought conveniently into your classroom, this picture brings to your class the seasonal story of the changes in trees. It is an excellent introduction to the scientific study of trees, a rich background for reading and language activities, including supervised field trips and field study of trees. Classification, seasonal aspects, and careful observation are stressed.

Seeds Grow Into Plants 10 min. Col. Pri., Int.

Seeing the many ways in which little seeds travel, observing the embryo plant inside a bean seed, and watching the growth of a seed into a small plant, children become familiar with the conditions necessary for seed growth.

Spring On the Farm 11 min. Col. Pri., Int.

Portrays the adaptation of plants and animals to the changing seasons, this delightful film follows Joan and Jerry as they observe the spring scene on the farm. They see buds swelling, birds returning, grass becoming green, fruit trees blooming, the planting of gardens, moths coming out of their cocoon, and young rabbits emerging from their nests.

Summer Is An Adventure | 11 min. | Col. | Pri., Int.

What a wonderful season summer is! For Fred and Judy, it's a time for being out doors, for fun at the beach, catching fireflies, and picnicking. It's a time for seeing colorful flowers, plants, birds, and insects, for walking in the woods, and for enjoying long, warm and bright days.

Summer On The Farm | 10 min. | Col. | Pri., Int.

Describes the cycle of seasons. Observing the growth of plants and animals during summer becomes a fascination experience as we follow Joan and Jerry in their ramblings by the pond, through the orchard, and into gardens and fields. The children finally return to the house where Mother has cut the first ripe water-melon of the season.

Wonders Of Plant Growth | 11 min. | Col. | Pri, Int.

Jimmy and his sister discover some ways that plants reproduce themselves. They grow plants from a bean and squash seed, the stem of a geranium, the leaf of a succulent and the root of a sweet potato. Fascinating time lapse photography helps the child to understand the process of growth.